THE CRITICAL SUCCESS FACTORS OF CLOUD BASED APPLICATION IMPLEMENTATION IN CONSTRUCTION MANAGEMENT

MOHD ASFAHANI BIN SUKIMAN

FACULTY OF BUILT ENVIRONMENT
UNIVERSITY OF MALAYA
KUALA LUMPUR

2020

THE CRITICAL SUCCESS FACTORS OF CLOUD BASED APPLICATION IMPLEMENTATION IN CONSTRUCTION MANAGEMENT

MOHD ASFAHANI BIN SUKIMAN

RESEARCH PROJECT SUBMITTED TO THE FACULTY OF BUILT ENVIRONMENT UNIVERSITY OF MALAYA, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF PROJECT MANAGEMENT

2020

UNIVERSITI MALAYA

ORIGINAL LITERARY WORK DECLARATION FORM

Name of Candidate: Mohd Asfahani Bin Sukiman
Registration/Matric No: BQB 180020
Name of Degree: Master of Project Management
Title of Research Report ("This Work"): The Critical Success Factors of Cloud Based Application Implementation In Construction Management

Field of Study: Project Management

I do solemnly and sincerely declare that:

(1) I am the sole author/writer of this Work;
(2) This Work is original;
(3) Any use of any work in which copyright exists was done by way of fair dealing and for permitted purposes and any excerpt or extract from, or reference to or reproduction of any copyright work has been disclosed expressly and sufficiently and the title of the Work and its authorship have been acknowledged in This Work;
(4) I do not have any actual knowledge nor do I ought reasonably to know that the making of this work constitutes an infringement of any copyright work;
(5) I hereby assign all and every right in the copyright to this Work to the University of Malaya ("UM"), who henceforth shall be owner of the copyright in this Work and that any reproduction or use in any form or by any means whatsoever is prohibited without the written consent of UM having been first had and obtained;
(6) I am fully aware that if in the course of making this Work, I have infringed any copyright whether intentionally or otherwise, I may be subject to legal action or any other action as may be determined by UM.

Candidate's Signature

……. Date:…….
Subscribed and solemnly declared before,

Witness's Signature

……. Date:……...……..
Name:
Designation:

THE CRITICAL SUCCESS FACTORS OF CLOUD BASED APPLICATION IMPLEMENTATION IN CONSTRUCTION MANAGEMENT

ABSTRACT

Design and construction are information intensive activities, involving a great number of people collaborating to produce complex, one-off developments. Whilst historically, information may have been managed and communicated using paper-based systems and verbal instructions, the integration of the supply chain, the introduction of computer aided design (CAD) and building information modelling (BIM) and the development of cloud computing application means that information communications technology (ICT) is becoming a fundamental part, not just of the design office, but also of the construction site. Cloud computing is a relatively new phenomenon in the construction industry. It allows the delivery over the 'cloud' (the internet) of a range of computing services, such as storage, databases, networking, servers, software and analytics to allow building professionals access to faster and more flexible information resources. However, the absence or lack of legal and regulatory support as well as guidelines on implementation of cloud-based application in the construction industry has become a hindrance for its adoption. In this research, the critical success factors for cloud-based application implementation are analysed, as well as its impact to project success. Through literature review, the critical success factors, the application software and tools are identified. Furthermore, a survey is conducted, to get an overall overview on the utilization of cloud-based application among construction professionals as well as on the effective critical success factors for implementation. The research then concluded the impact that cloud-based application has to project success.

Keywords: construction, cloud computing, information communication technology

FAKTOR KEJAYAAN KRITIKAL PELAKSANAAN APLIKASI BERASASKAN CLOUD DALAM PENGURUSAN PEMBINAAN

ABSTRAK

Reka bentuk dan pembinaan adalah aktiviti yang berintensifkan maklumat, yang melibatkan sebilangan besar orang yang bekerjasama untuk menghasilkan satu projek pembangunan yang kompleks. Walaupun secara sejarahnya, maklumat mungkin dikendalikan dan dikomunikasikan menggunakan sistem berasaskan kertas dan arahan lisan, penyatuan rantaian bekalan, pengenalan reka bentuk berbantukan komputer (CAD) dan pemodelan maklumat bangunan (BIM) dan penkembangan cara aplikasi pengkomputeran awan bahawa ICT menjadi bahagian asas, bukan hanya pejabat reka bentuk, tetapi juga tapak pembinaan. Pengkomputeran awan (cloud) adalah fenomena yang agak baru dalam industri pembinaan. Ini memungkinkan penyampaian melalui 'cloud' (internet) pelbagai perkhidmatan pengkomputeran, seperti penyimpanan, pangkalan data, rangkaian, pelayan, perisian dan analitik untuk membolehkan para profesional bangunan mengakses sumber yang lebih cepat dan lebih fleksibel. Namun, ketiadaan atau kekurangan garis panduan pelaksanaan aplikasi berasaskan cloud dalam industri pembinaan telah menjadi halangan untuk penerapannya. Dalam penyelidikan ini, faktor kejayaan penting untuk pelaksanaan aplikasi berdasarkan cloud dianalisis, dan juga kesannya terhadap kejayaan projek. Melalui tinjauan literatur, faktor kejayaan kritikal, perisian dan alat aplikasi dikenal pasti dan ditangani. Selanjutnya, tinjauan dilakukan untuk mendapatkan gambaran keseluruhan mengenai penggunaan aplikasi berasaskan cloud di kalangan profesional pembinaan. Tinjauan kemudian dilakukan terhadap faktor kejayaan kritikal yang berkesan untuk pelaksanaan. Penyelidikan kemudian menyimpulkan kesan aplikasi berasaskan cloud terhadap kejayaan projek.

ACKNOWLEDGEMENTS

In the name of Allah Most Gracious and Most Merciful. Peace be upon Prophet Muhammad S.A.W., his family, his companions and followers of his guidance.

First of all, Alhamdulillah, I thank ALLAH S.W.T for giving me ideas and physical strength in preparing this research. Completion of a project of this nature requires more than just the efforts of the author alone.

I am really fortunate that, I had the kind association as well as supervision of Dr Nurshuhada Binti Zainon. Her exemplary guidance, support and careful supervision throughout the preparation of my research are so great that, even my most profound gratitude is not enough.

I am extremely grateful to my family, especially my beloved wife Norfaiza Binti Ab Malik, and my parents Sukiman bin Surahman and Rashidah Hanim Binti Abd Hamid, for their unwavering love, prayer, support and understanding throughout my studies.

My special thanks and deep sense of appreciation to all of my course mates whom have been involved and provided their assistance directly or indirectly in the preparation of this research. They have introduced me to a whole new meaning of companionship and camaraderie, and I will never forget these days of mine at UM.

Thank you.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF SYMBOLS AND ABBREVIATIONS

Symbols/ Abbreviations	Description
API	Application Programming Interface
ASP	Application Service Provider
BIM	Building Information Modelling
CAD	Computer Aided Design
CBS	Cloud Based Software
CC	Cloud Computing
CFS	Critical Success Factors
CIO	Chief Information Officer
CSP	Content Security Policy
IDS	Intrusion Detection Systems
FCCI	Federal Cloud Computing Initiative
IaaS	Infrastructure as a Service
ICT	Information Communication Technology
IFC	Industry Foundation Classes
IT	Information Technology
KLSE	Kuala Lumpur Stock Exchange
NIST	National Institute of Standards and Technology
PaaS	Platform as a Service
PM	Project Manager
RII	Relative Importance Index
SasS	Software as a Service
SME	Small Medium Enterprises
SPSS	Statistical Package for Social Science

LIST OF APPENDICES

CHAPTER 1: INTRODUCTION

1.1 Introduction

Cloud computing is a relatively new phenomenon in the construction industry. It allows companies to outsource data, electronically mail, folders and other applications through virtual platforms through the medium of servers that are connected between them and that can be access anywhere and at any time (Ilie, 2015). That means with the assistance of cloud computing, architects and engineers can collaborate on a project which is being executed in the office of an architectural and engineering company even when they are at different locations. Cloud computing is the foundation of construction's digital revolution. It underpins all the most powerful software solutions, and truly enables the industry to take advantage of the latest tech.

Lately, progress in the web information exchange rate have expanded the utilization of cloud-based assistance by companies to manage projects and provide a way to store and retrieve an immense amount of data and information. It has evolved from personal cloud storage to entire organizations moving all of their data to the cloud. Cloud computing offers several benefits for large organizations such as mobility, increased efficiency, cost-effectiveness, streamlined collaboration, and speed of connectivity (Ashok, 2017).

Adaptable capacity and information sharing as results and resources can be kept in the cloud, which gives practicality boundless store and calculation limits. Records and documents can be generally altered and partaken in the cloud, a portion of the Public administrations are given by Google docs, live SkyDrive, and Office Live Universal access to the computational assets, as the clients can study and access the assets at any given place, time and from any device without setup endeavours.

1.2 Problem Statement

1.2.1 Increased Complexity of Construction Projects

Construction projects are often referred to as being complex and is a key characteristic. It is the degree of complexity that determines the overall approach to a project, specifically the required resources as well as tools and techniques. Construction is often described as a complex and risky business, Baccarini (1996) states that the construction process may be considered the most complex undertaking in any industry, however the construction industry has developed great difficulty in coping with the increasing complexity of major construction projects. Therefore, an understanding of project complexity and how it might be managed is of significant importance for achieving successful projects for all the parties involved. This is supported by Mills (2001) who describes the construction industry as one of the most dynamic, risky and challenging businesses and goes on to say however, that the industry has a very poor reputation for managing risk, with many major projects failing to meet deadlines and cost targets. Mulholland and Christian (1999) support this accusation further by adding that construction projects are initiated in complex and dynamic environments resulting in circumstances of high uncertainty and risk, which are compounded by demanding time constraints.

Baccarini (1996) proposes a definition of project complexity as "consisting of many varied interrelated parts and can be operationalised in terms of differentiation and interdependency." Baccarrini explains that this definition can be applied to any project dimension relevant to the project management process, such as organisation, technology, environment, information, decision making and systems, therefore when referring to project complexity it is important to state clearly the type of complexity being dealt with.

Complex construction projects, if not managed properly could lead to inefficient data processing and management which usually occurs due to problems associated with resource utilization, budgeting, monitoring and control during a project. The processes mentioned requires huge amount personnel to manage, which is usually overlooked during a projects design and planning stage. Personnel requirements could range from data analyst, to document controllers, to data entry clerks. As a result, the company could be paying unnecessary labour costs as a result of overstaffing to manage information and data received during a projects construction phase. Coordinating various monotonous tasks with the dependence that organizations have on a smooth day by day work processes makes it basically difficult to keep up any sort of competitive edge. However, this is the way most organizations operate.

The way toward planning, repurposing, developing and operating a structure include not just the conventional disciplines (Architecture, Structure, and Mechanical & Electrical) yet additional numerous new professions in areas, for example, energy, condition and waste. These professions have huge information sharing necessities. In this specific situation, information management within the industry can regularly be divided with an absence of general information management policy. Data and information management plays a major part in its contribution to projects duration. If not managed properly, could lead to time consuming processes and delays. A huge amount of effort has been spent improving information management in the construction industry. However, there are still many problems in information, data transfer and processing between project participants that could hamper the overall project duration and cost. Because a procedure has been executed one direction for quite a while does not really assembles it as the best choice. In light of their absence of perceivability and failure to comprehend the effect of a bottleneck, organizations regularly neglect sources of procedure slowdowns. These bottlenecks are at times the consequence of not revamping and acclimatizing to new

advances. Notwithstanding the reasons, process obstacles can cause real slowdowns, with broad financial effect.

1.2.2 Delayed Implementation of Cloud Computing in Construction Industry

Several studies have found that cloud computing has increased productivity, performance, and some organizations has acquired significant advantage in adopting cloud services. Over the years, technology emergence has helped to enhance the growth of Cloud computing, but the growth had not been as per expectations in the beginning era of the Cloud computing. There are notable factors that have hindered the growth of cloud computer over the years. In the beginning, most of the growth in Cloud computing is noticeable in small and medium enterprises as compared to large corporations. The adoption of Cloud computing was slower due to various reasons such as mobility, bandwidth, the fear of losing control, security, privacy, data protection, performance and uptime, lack of Cloud business brokers, and unawareness (Zhang et al, 2010).

1.2.3 Absence of Procedural Guidelines, Legal, and Regulatory Support for Cloud Platform Implementation in Construction Management in Malaysia

Cloud computing has become an increasingly popular approach in recent years, with seemingly nothing but ongoing growth in its future. However, some industry observers say that the rapid growth has caused, and is also threatened by the failure of comprehensive cloud-computing standards to gain traction, despite the many groups working on them. The lack of procedures and regulatory support could make cloud computing trickier

to use. It could also restrict implementation by limiting interoperability among cloud platforms and causing inconsistency in areas such as security and interoperability.

Although cloud technology has been around for quite some time in the information and technology sector, its implementation on the construction industry, at a corporate level is still a work in progress. At its most basic, cloud computing is simply the delivery of applications; security and other services; storage and other infrastructures; and platforms such as those for software development to users over the Internet or a private cloud. Cloud computing appeals to many organizations because it minimizes the amount of hardware and software that users must own, maintain, and upgrade. In essence, users pay only for the computing capability they need.

All the above-mentioned issues arise because there are no established guidelines, legal and regulatory support or industry standard that defines a systematic approach to a successful adoption of implementing a cloud-based application for the construction industry in Malaysia. Procedures are designed to assist in reducing variation within a given process and allows for a smooth transition to new processes and technology.

1.3 Research Questions

This research will attempt to answer questions related to the issues of implementing a cloud-based application in construction management in Malaysia. The research focusses in the following research questions:

i. Is cloud-based tools or application currently being utilized by industry professionals to cope and manage construction deliverables?

ii. What are the success factors that affects cloud technology adoption in construction organizations in Malaysia?
iii. Which critical success factors influence the project success most?
iv. Does adoption of cloud-based application have significant impact to project performance?

1.4 Research Aim & Objectives

Limited legal and regulatory support as well as lack of implementation guidelines on the implementation of cloud for the construction industry in Malaysia, resulting in the issues described in the problem statement. Hence, the aim of this research it is to analyse the success factors for cloud based platform implementation and their impact to project performance in construction management in Malaysia. It seeks to achieve three objectives as follows:

i. To identify common cloud-based tools among construction professionals to manage increasing project complexity.
ii. To identify factors that lead to successful performance of cloud-based applications; and
iii. To determine the critical success factors (CSF) to implement a cloud-based platform their impact to project success in construction management.

1.6 Significance of Research

This study will hopefully provide the foundation for implementation of cloud technology to the construction industry as a whole. This research will identify the factors to be

focused on for a successful implementation and will create awareness and hope to provide them with characteristics of Critical Success Factors for implementing cloud-based application in construction management.

1.7 Scope of Research

There are various studies conducted on the implementation of cloud computing in numerous industries, but not many on the construction industry in Malaysia. The implementation of cloud-based management is still in its infancy in Malaysia for the construction sector, thus lacking information and details on proper implementation and framework for the industry. This dissertation will only cover analysis of critical success factors of implementation among organization in the construction industry in Malaysia due to time constraints and limited resources.

The study encompassed on the use of numerous cloud-based application currently in use for a range of computing services such as databases, cloud storage, networking, servers, and analytics to allow construction professionals access to faster, reliable and more flexible resources such as BIM, Google Drive, Dropbox and so on. From this dissertation, it would contribute and identify the the critical success factors to successfully implement this technology for the construction industry in Malaysia.

In order to achieve the research objectives, a study on several aspects related to cloud technology were carried out. The study encompasses the construction industry and the respondent for this research are professionals in the construction and engineering division from public listed companies in Malaysia. These respondents are chosen basically because they are directly involved with the implementation of cloud-based applications

which their companies have invested on to equip their organizations with tools to facilitate the completion of construction projects.

1.8 Research Methodology

Upon identifying the objectives and that the research limitation has been identified, the study was carried out using the methods described below:

i. Carry out literature review to discover further information on cloud-based platform in general, and how it tends to be executed effectively. This will help in accomplishing some portion of the first and second objectives of the research. This is additionally to ensure inside and out comprehension of the topic and to enhance knowledge level.

ii. Conducting field research by using questionnaire survey towards professionals in the construction and engineering department in public listed organizations, as they are more frequent users of cloud applications and services.

The following phase of research was to compile and manage the information received and conduct the analysis. The final phase stage was to present the analysed data and composing of the report with a conclusion and future suggestions. A diaphragm of the procedures involved is detailed in Figure 1.1.

1.9 Research Report Layout

This research is organized in five chapters. After the first chapter which comprise of an outline of the fundamental concepts of cloud platform and a review of the foundation for

the research, in Chapter 2, a critical review of the literature on which the research was based and to understand the important and analysed the literature relevant to the topic. It will also identify the research that has been completed in the topic area and will contain an analysis of all current information relevant to the topic.

In Chapter 3, the research methodologies which comprised a basic phase of the research information and data collection are discussed. This chapter will describe what the methods are all about and how it is executed.

Chapter 4 will be where “the body” or data analysis of the dissertation or thesis will be. This chapter will consist of the final results of the research, illustrates the findings and detail my analysis of them and the sub-conclusion of the research.

Chapter 5 concludes the research with a review of the research objectives and results, synopsis of discoveries, a layout of the suggestions for this research area and the essential contribution of the study and its conclusions. This chapter will also discuss the weaknesses in the research, the limitations of the research and suggestions for future work.

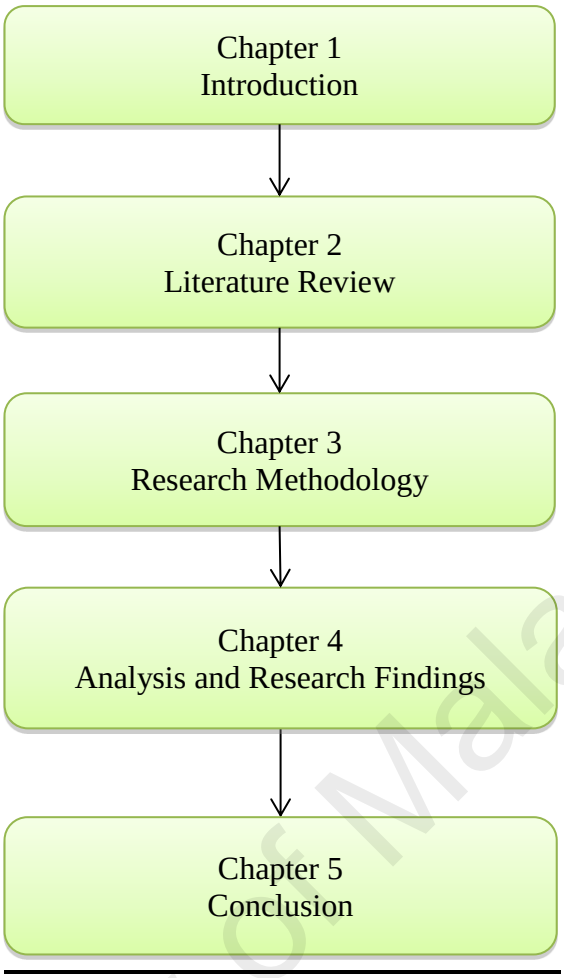

Figure 1.1: Research Phases

1.10 Summary

This chapter, the researcher explains an overview of the research topic, an introduction of cloud-based applications management for the construction industry. This chapter also explains the research's problem statement, research aim, research questions, and the objectives of the research. The research methodology and scope of research is also included in the chapter to make the research clearly defined and avoid misconception.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Cloud computing is an emerging phenomenon and has been a major agenda in the field of computing over the last decade. The ability to facilitate speed, agility, flexibility, infinite elasticity, innovation as well as economic advantage, this emerging technology has the potential to increase the rate of responsiveness of IT organizations (Hamid et al, 2015). Critical review of the literature is an essential procedure that makes a firm establishment for propelling knowledge; it encourages revealing areas where research is required (Webster, Watson, 2002).

This part goes for efficiently looking into the writing of literature to indicate the current state of research regarding cloud platform implementation issues. This review procedure pursued the essential rules for conducting an effective literature review, and it is done inside limits identified (Webster, Watson, 2002). The relevant limit for this review is the clients, not people, as there are huge issues that should be tended to before organizations begins utilizing cloud platforms (Marston et al, 2011; Dubey, Wagle, 2007).

2.2 Cloud Computing Definitions

The idea of cloud computing being delivered as an open utility, which indicates the early ideas of cloud computing back as early as the 1960s by John McCarthy. However the idea faded in the 1970s because of the lack of technology to accommodate it. Eric Schmidt, who is Google‘s CEO, brought back the idea when he mentioned the term "cloud computing" in 2006, and a wide debate within the computing industry was triggered. The expression “cloud”, which is only a relative similitude for both the Internet overall and

applications and information that are facilitated inside it, offers organizations the open door for versatile and virtualized authority over their organization ‘s information management infrastructure.

The term “Cloud” is an information technology term with some variable definitions. In most cases, it refers an application or a virtual storage server accessible to the user over an internet connection. Obtaining entry as such is often alluded to as utilizing cloud based or online administration services. To some others, they allude to the cloud as any sort of use or information data storage that is utilized outside of an organization’s firewall. The definition of “moving to the cloud” accounts for several meaning from transferring or storing information and resources, expanding data and information limit without putting resources into additional IT infrastructure, to giving licence to a new generation of subscription based and web visible programming.

With ever advancement of mobile devices, this allows the cloud definition to further expand its mobility to incorporate the utilization of mobile devices, for example, tablets or smart phones. Buyya et al. (2008) developed definition of cloud computing which features the connection specialist organizations and cloud administered clients. They depicted cloud computing just like a parallel and regulated framework comprising of virtualized computers that are progressively orchestrated as bound together processing computing resources based on service-level agreements worked out between a vendor and its clients. Staten (2008) depicted a generally limited definition where cloud computing is seen as a pool of versatile and preoccupied processing foundation for facilitating end user applications fit for being charged based on utilization. From the plan of action point of view, Armbrust et al. (2009) alludes to cloud computing as the applications conveyed as administrations over the web as opposed to the equipment and framework programming in the server centres.

For the purpose of this dissertation, I adopt the comprehensive definition of cloud computing as defined by the National Institute of Standards and Technology (NIST) based in the United States. According to NIST, cloud computing is defined as "a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction". By this definition, not exclusively is cloud computing an imaginative advancement of computing innovation, yet in addition another plan of action for conveying IT based solutions (Iyer and Henderson 2010).

Cloud computing innovates from a few predecessors, for example, grid computing (Srinivasan and Treadwell 2005; Channabasavaiah et al.2003), utility computing (Rappa 2004), and web administrations (Berbner et al. 2005). As another plan of action, cloud computing has changed organizations in a few different ways, for example, disposing of the requirement for in advance IT investment costs and the requirement to maintain local data servers, but the most noteworthy favourable edge of cloud computing is cost decrease.

Cloud computing is described by various capacities and qualities. Table 2.1 abridges some key qualities from the scholastic writing and industrial reports of research establishment. These qualities separate cloud computing from other data and information management advancements and indicates that cloud computing to be something in excess of basic innovation.

The NIST has depicted three cloud platform models: Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). Iyer and Herderson (2010) has correspondingly classified cloud computing merchants reliant on numerous elements of thought. Merchants at the foundation level, for example, Amazon, give

essential processing resources such as devoted servers, memory, and capacity. Merchants at the stage level, for example, Microsoft and IBM, give advancement domain which enables clients to develop new applications. Merchant at the product level, for example, Google, offer on programming rental on request. It merits indicating that SaaS is not the same as the ASP (application service provider) model in that SaaS can accomplish economies of scale by giving a one size fits all arrangements.

Table 2.1: Key Qualities of Cloud Computing

Characteristic	Description	References
On-demand service	Services or computing capacity is accessible as required as needed.	Mell and Grance (2011)
Ubiquitous access	Services can be accessible through the internet.	Armbrust et al. (2009), Mell and Grance (2011)
High elasticity and scalability	Processing capacities can be flexibly provisioned, and powerfully scaled up or down with interest.	Mell and Grance (2011), Qian et al. (2009)
Pay-per-use	Clients are charged for genuine utilization of administration rather than by membership.	Armbrust et al. (2009), Staten (2008)
Location independence	Clients can get to information and administrations without knowing its physical area.	Iyer and Henderson (2010)
No upfront commitment	Associations can begin little and increment assets as required	Armbrust et al. (2010)

The IT industry is represented by a new buzz in cloud computing and makes way for a few cloud specialist providers by developing organizations. Amazon Elastic Compute Cloud (Amazon EC2) was among the first. As one of the early developer and service provider, Amazon is at present the biggest market share winner and supplier of the overall industry. Table 2.2 indicates a several of the major cloud specialist providers with

separated into the three service models depicted by NIST. Cloud computing applications have been created for the need of numerous zones, for example, web-based collaboration services, healthcare, scientific research, business applications, R&D projects for testing new services and applications and design models (Hand 2007; Staten 2008).

2.3 The Actuality and Vision on Implementing Cloud Services

Cloud computing has been on the vital plan of a developing number of organizations since it gives answers for the particular difficulties faced by organizational IT divisions. These difficulties incorporate the issue of adjusting time to market against resource use, the challenge of capacity planning, and the organizational need to develop IT infrastructure without definite marketable strategies and without spending endorsement (Staten 2008). These issues relate (somewhat) to keeping up in-house server or on-premise software applications. As another IT re-appropriating model, cloud platform offers option with two noteworthy advantages.

In the first place, utilizing cloud administrations has huge financial focal points. Cloud computing has the ability to essentially decrease cost by disposing of both the need to maintain propriety infrastructure and the requirement for direct front capital venture (Jaeger et al.2008). The pay upon request model converts capital costs to operating cost and enables cash-flow to be diverted toward interest in the core business (Armbrust et al. 2009). Another explanation behind its monetary leverage is that cloud specialist developers have phenomenal negotiating power with regards to support contracts, equipment evaluating, and programming authorizing.

Table 2.2: Cloud Computing Services		
Service	Vendors	Description
IaaS	Amazon	Simple Storage Service (S3); cloud storage; Elastic Compute Cloud (EC2) virtualized cloud infrastructure;
	VMware	Vblocks
	Rackspace	Rackspace Cloud: Cloud Sites, Cloud Servers, Cloud Files
	Joyent	Joyent Accelerators (virtual servers)
	3Tera	AppLogic: provides infrastructure solution
PaaS	Google	A stage for creating and facilitating web applications in Google-managed servers; underpins Python and Java.
	VMware	vCloud: oversees applications inside private clouds or has them unified upon request to accomplice facilitated open clouds
	Salesforce.com	Force.com Platform (Custom Cloud 2, Development Platform)
	Microsoft	Azure: a Windows-as-an administration stage comprising of the working framework and designer administrations
	Joyent	OpenSolaris
	IBM	Blue Cloud computing platform: improves programming advancement and conveyance abilities, especially in huge organizations
	NetSuite	SuitCloud: offers on-request items, advancement instruments, and administrations
	3Tera	Cloudware: offers capacity and applications.
SaaS	Google	SaaS: Web-based correspondence, joint effort, and security applications including Gmail, Google Calendar, Google Talk, and Google Docs.
	Salesforce.com	CRM (Sales Cloud 2, Service Cloud 2)
	NetSuite	SuitCloud:, improvement apparatuses, administrations and offers on-request items

For instance, Amazon costs RM300-RM600 every month completely troubled for a server versus a normal of RM1600 every month for an in-house server (Staten 2008). The second advantage is flexibility. Cloud computing can oblige new administrations inside hours as

opposed to weeks, and can deal with outstanding tasks at hand intently by progressively scaling up or down. Armbrust et al. (2009) refered to Target and Amazon as guides to indicate flexibility benefits for both new companies and settled huge organizations: while different retailers have extreme execution issues amid Black Fridays, Target and Amazon's locales were just slower by half. This precedent likewise recommends another advantage of cloud computing: hazard transference, particularly the danger of under or over provisioning.

Alongside advantages of cloud computing talked about, parallel with benefits as discussed above for cloud computing, several concerns and vulnerabilities which has current organizations kept down from accepting it. Jaeger et al. (2008) laid out a portion of the potential arrangement issues introduced by distributed computing including protection, security, unwavering quality, access, and guideline. Unwavering quality raises noteworthy issues when administration interruptions happen, or information respectability and exactness is undermined. Anonymity, privacy and security are the most pressing worries for cloud clients thinking about having content observed by outsiders or the unapproved arrival of sensitive information. Access and use limitations might be issues for cloud suppliers since they need to stress over licensed innovation infringement and other unlawful use by certain clients. Rochwerger et al.(2009) investigated factors that activate cloud computing as a universally useful open figuring utility, including: consistently propelling equipment and programming innovation; the proceeded with entrance of web; decreasing security and trust worries with respect to clients; and the omnipresence of representation. Contrary to these drivers organizations may likewise confront impediments in the reception of cloud computing. These snags can basically be sorted into either specialized or hierarchical impediments (see Table 2.3). It is contended that a portion of the specialized impediments may just be legitimate for a specific timespan (for example the beginning period of cloud computing) however are in no way,

shape or form inconceivable later on. For example, the absence of interoperability (Rochwerger et al.2009) between cloud suppliers will be fathomed as cloud computing advances after some time, and benchmarks and conventions for improving interoperability will be created.

Table 2.3: Obstacles to the Growth of Cloud Computing

Obstacles		**Description**	**References**
Technical Obstacles	Availability of service	Clients expect cloud administrations to be conveyed with high accessibility and unwavering quality	Armbrust et al. (2010); Armbrust et al. (2009), Chow et al. (2009), Dikaiakos et al. (2009), Ranjan et al. (2012), Rochwerger et al. (2009)
	Data lock-in	Clients experience issues removing information starting with one merchant then onto the next because of an absence of interoperability	
	Data confidentiality and auditability	Delicate information might be presented to greater security dangers and certain auditability necessities should be met	
	Data transfer bottlenecks	Information exchange over the web could be expensive	
	Performance unpredictability	Clients need quality of service guarantees, paying little mind to outstanding burden or utilization of assets inside the cloud	
Organiza-tional Obstacles	Differences over the pace of adoption between business and IT executives	While business needs to push ahead to a full cloud implementation, IT will in general continue all the more gradually as a result of worries about security, effectiveness, and management	HP Business White Paper (2011), Garrison et al. (2012)
	Different stages of maturity along an adoption continuum	Organizations that have embraced virtualization are progressively prepared to receive cloud computing	
	Uncoordinated adoption	Organizations approach the cloud in a divided manner without a general reception technique	

	Inadequate business and technical acumen	The advantages of cloud computing may not be completely acknowledged when cloud platform of an insufficient comprehension of extension, range and usage.	

2.4 Cloud Computing in Construction Management

2.4.1 Application of Cloud Platform in Construction Management

The contribution the construction industry is to economic growth and long-term national development is widely acknowledged, highlighting its importance, especially to developing nations (Ofori 2015). It is one of the sectors that provide essential ingredients for the development of the economy. Elements of the process of construction industry development that have been studied include means of improving the performance of construction firms, focusing on contractors and technology development. However, current market demands had led to it becoming more complex because of the sophistications of the construction process itself, increased emphasis in quality, time and cost, and larger number of parties involved in the construction process in order for it to be successful.

2.4.2 Benefits of Cloud Platform to Construction Firms

Many participants from different organizations have to carry out a vast number of differ ent activities in construction management, working together simultaneously. This resulting in a huge amount of information and data that must be delivered and communicated throughout the project (Kornelius and Wamelink, 1998; Dawood et al.,

2002; Pietroforte, 1997). With a great rate of developments in IT technologies, openings become evident in improving correspondence between members in development ventures and in permitting a proficient and successful communication (Dawood et al., 2002; Egbu et al., 2001; Anumba and Ruikar, 2002). Below we look at how cloud platform can benefit the construction industry:

2.4.2.1 Accessibility

Cloud computing eliminates the necessity to email or transfer numerous document versions between teams. Online applications and tools can be utilized to alter the reports in the cloud, guaranteeing that everybody knows and working on the most recent adaptation. Moreover, as the record size develops, the presentation and access never show signs of change — this is significant on portable and lesser gadgets with equipment limitation. It eases the additional worry of sharing and coordinated effort between third parties, teams, even sub-contractual workers (Matthews, 2018). This will also stimulate change and innovation in the construction industry. Continued industrial digitization provides the perfect opportunity to apply new ways of planning and implementing a construction project.

An important concern for the industry is also on reliable data analytics and processing. A large proportion of construction work is carried out on construction sites, during construction itself, where in most cases access is limited to computing resources. This has an important impact to commercial, where it is one of the major challenges to ensure up-to-date and correct construction site plans are delivered and used. It is highly desirable to be able to allow users to make changes on site to a portable device, which can then be processed remotely to update plans on-site (Beach et al, 2013).

2.4.2.2 Mobility and Cost Savings

Due to the constant change in project staff and frequent installation of new locations, the appeal of using the cloud service has further increased. Numerous representatives will require better access to organization information to help in convenient, well-supported decision making and coverage whereas operating within the field. In contrast, the headquarters balances the requirement for processing payroll, paying invoices, billing, logistics planning and producing financial reports with the requirement for off-site employees update and access information regardless of their location. Customary customer/server programming arrangements give clients access to this data from assigned areas which must be set up during the early stages.

With cloud technology, insofar as there is a functioning web association, cloud administrations and both online programming or equipment stay accessible and this has opened up new conceivable outcomes that enable instant connections with be made past these conventional preconstructed site offices. Wherever one can access the Internet, it is currently conceivable with the cloud to take advantage of back-office data and other resources as well as revealing usefulness from any area in an exceptionally secure manner. This enables organizations to associate separate jobsites by enabling everybody in the group to take advantage of a similar system or framework It manages a mind blowing dimension of understanding about what a group is doing, what work they are at present centred around, or even how they can team up or give help. Development organizations are situated to pick up from the cloud's capacity to arrangement more noteworthy opportunity and encourage access to data whenever, anyplace, from headquarters to client locations and subsidiaries, job sites, satellite offices, or others that can span across the globe.

2.4.2.3 Improved Collaboration & Coordination

The last decade, a lot of research exertion has gone into development of IT in construction. However, take-up of IT in the business is still generally low (Kumar, Cheng, and McGibbney, 2010), specifically, the SMEs in this part have one of the least takes-up of IT among most other comparable areas. In today's construction atmosphere, progressively remarkable spotlight on supporting and ensuring common and HR is of critical factors considered during the designing, planning and developing a project. Therefore, the real exertion will be to improve the coordination, joint effort and interchanges inside the construction management at the beginning periods of design and planning. These elements could have negative ramifications for the objectives of the project which could impact the safety, quality, cost, and finishing time (Norshakila et al 2013).

With clients as major parties in a project, they will likely demand that the project to be delivered with higher quality, cost productive, shorter development time and accomplishing exact and modern data inside the construction ventures, will prompt the improvement of creative community innovations for the construction industry. As such, this is where cloud-based application software's or platforms can be used to achieve these demands as it could be applied in various respects to the construction industry, including but not limited to analysis of structure, design architecture, procurement management, estimating of cost, and planning and control of a project.

2.4.2.4 Real time progress management

Construction projects are data concentrated and approaching exact data in the exact spot and at the right time are significant for basic leadership and ensuring an undertaking is conveyed as per pre-characterized parameters that have been set up at its beginning (Li,

Love, P.E.D. & Gunasekaran, 1999). The capacity to furnish a temporary worker with the expected data to enable construction to be completed as required, with effectiveness and without deterrent is a key attribute of good quality process. Infrequently, be that as it may, is structure and designing documentation (for example two-dimensional (2D) illustrations and details) created with all the important data required for development. Hence, there is a proclivity for contractual workers to be provided with fragmented, clashing and mistaken records (Tilley, Barton, 1997). The provision of insufficient information during the progress of construction has been reliably observed as a factor that has added to poor profitability and revise, which thusly coming about to calendar and cost invades being acquired, and questions (Akinsiku, Akintunde, 2012; S. Andi, Minato, 2003; & Chan, 2004). To undertake this task, existing paper-based processes were reproduced to accommodate the use of cloud-based platform during construction. The design and implementation of a real-time object-oriented bi-directional system, allowed information (e.g., the status of the 'As-Built' schedule) to be captured on-site and synchronized with a federated cloud-based application. A new object-oriented workflow and processes for progress management are formulated as a result of adopting cloud-based technology in construction.

2.5 Cloud Based Software (CBS) Commonly Used in The Construction Industry

A new technological surge has begun amongst industry leaders in the construction and project management industry that involves the use of construction information management on cloud-based software's (CBS) (Christianson, Wilson, Henke, Alhnaity, and Woo, (2017). CBS programs can drastically improve collaboration between project managers, supervisors, QA/QC managers, office managers, and field managers/foreman. There are many different types of cloud-based software programs currently available on

the internet. Some for free, others at a cost. Only some of these are construction project and company management-based software programs. Others are more focused on financial/cost control or online document storage and collaborations. The majority of these programs are typically geared towards, or used for, certain singular functions involved with a construction company: i.e. daily logs, photos/construction documents, or time clock management. Some companies use cloud-based software for photos, some use it only for scheduling needs, and many respondents claimed to not be using CBS at all. Ultimately, most companies pick and choose what they want to use IT strategies for rather than invest their entire company into it.

2.5.1 Cloud Based Project Management Tools

The complexity of today's construction industry where large number project deliverables, on top of supplies and human resource is to be managed by the companies. Reducing their cost, focus on product development and focus on the clients is essential to stay competitive. Project management knowledge focused on core skills in the areas of budgeting, scheduling, and resource allocation. Hence, it is critical that in assisting with these processes project management tools are utilised, as they provide scheduling, planning, communication, documentation solutions, and resource allocation features.

Increasing of project complexity and their schedules, to say that most project today is managed by Project Management Software is no exaggeration. There are many industry-leading tools for creating, managing and tracking project schedules and generating related reporting that could be used to make insightful decisions about projects. Having timely access to information on the performance of a construction project enables the design

team and contractor to improve their decision- making so as to ensure project deliverables are met.

2.5.2 Building Information Modelling (BIM) Tools

With BIM integrated in cloud-based model, which is widely known as BIM of second generation, not only it provides platform for real time communication more effective but also allows collaboration and cooperation of higher level among project team members. With this being said, in the construction this technology is relatively new. A study conducted by Redmond et al. (2012) discover how cloud BIM improves the exchange of information through semi-structured interviews with 11 experts. The research concluded that cloud-based BIM enables different disciplines to create opportunities to exchange and share necessary data for important decisions to be made during preliminary design stage. It was suggested by Porwal and Hewage (2013) that the integration of BIM framework with cloud computing enables construction to be sustainable throughout a projects lifecycle by facilitating pre-planning. However, Chong et al. (2014) reviewed six cloud-based BIM systems, Autodesk BIM 360, Cadd Force, BIM9, BIMServer, BIMx and Onuma System, found that private clouds is only supported only by three of systems mentioned and IFC filed is only recognized by two of them. It was also iterated by Chong et al. (2014) that small contractors may not benefit cloud-based BIM software with large contractors meets the need requirement of five types of software. Some cloud-based BIM studies have focused on the development of frameworks or implementation models. A study by Kumar and Cheng (2010) reviewed framework suggested and cloud computing technology in the construction sector for the implementation of cloud computing for exchange of information. They indicated the key to success to implement cloud is the interoperability. A framework was developed by Juan and Zheng (2014) that a hybrid

cloud deployment with BIM by describing how in a real construction project the system could be applied. A BIM based augmented reality system was developed by Meza et al. (2014) using an environment of cloud computing in the data phase. Be that as it may, only information sharing utilized cloud computing platform and details of how implementation of cloud was carried out was not provided in the study.

Only a limited number of scholarly works were identified in the literature due to cloud computing in construction sector is novel. Building design/planning and construction phases is observed to be the current application of cloud-based BIM, while it is overlooked in its application in the facility management and maintenance, energy efficiency, operations and deconstruction and demolition stages. It was suggested by Jiao et al. (2013) that cloud-based application is a useful tool for managing data during the lifecycle of AEC and facilities management, however, elaborate details was not provided. The few studies on evaluating the effectiveness of cloud BIM was also another problem in available cloud-based BIM research. Although Jiao et al. (2013), evaluated the effectiveness of implementation, detail is lacking about how the evaluation was conducted and the evaluation methods. In future research, studies should focus on developing a structured methodology for evaluating cloud BIM.

2.5.3 Cloud Based Tools for File Sharing

Cloud based storage are becoming an increasingly popular service. Cheap storage space solutions provided by an influx of service providers in, high amount internet traffic is expected to increase as expected, generated by cloud storage services. Cloud-based service has been introduced in recent years (Zhang et al, 2010), with storage capacity, remote data centres and moving away from complex hardware management being offered

to users and organizations. With providers such as Google, Microsoft and Amazon entering the market directly towards the end of April 2012, a rush was witnessed on offering storage solutions on the internet. They face are already joining an area established by popular services such as Dropbox, UbuntuOne and SugarSync. The former, active since 2007, currently counts over 50 million users, uploading more than 500 million files daily. Users have been relying on cloud-based storage solutions in construction management, due to is efficiency to transfer data and share information anywhere and anytime, as long as the internet is accessible. With the complexity of data and information in the construction management that is involved, the popular use of cloud storage solution will only increase.

2.5.4 Cloud Based Tools for Document Management

Private information and making them useful for daily task and ensuring it is properly handled has increased by the managing organizations. Challenge arise for information efficient usage and management due to the variety and number of documents. In an information-rich community today, an issue today arises in how to achieve efficient management of documents. Two significant features are aimed to be provided by the document management system. First is the ability for the latest information to be accessed anywhere, anytime and from any hardware or device timely. Because of the amounting device and hardware diversity, users are provided the mechanism of management and access of corresponding document without complex operations and extra learning burdens. The second feature is the support for collaboration and efficient document sharing for the working environment to ensure cooperation. The objective of the document management system is to extend such sophisticate features and ease the complexities to organization users and applications.

2.6 Issues and Challenges with Cloud Computing in Construction Management

There is little doubt that companies can gain huge benefits from cloud computing such as value savings, strategic edge, manageability, reliability, scalability, access to automatic updates. However, there are numerous issues to cloud computing that prevents its successful implementation. Some of the research issues are discussed below:

2.6.1 Data Security Concern

Cloud computing has huge potential prospects. However, the threats with regard to security inserted in cloud computing approach are straightforwardly relative to its offered advantages. As cloud computing as a rule implies utilizing open systems and, in this manner, putting the presented information to the world, digital assaults of any sort are foreseen for cloud platform. The current cloud-based administrations have been found to experience the ill effects of powerlessness issues with the presence of conceivable security escape clauses that could be abused by an attacker. Protection and security both are worries in cloud platform because of the idea of such processing methodology (Bisong and Rahman, 2011). The methodology by which cloud computing is done has made it inclined to both system security and data security issues (Qaisar & Khawaja, 2012; Rashmi, Sahoo & Mehfuz, 2013).

A risk may rise up out of third-party relationship for cloud condition nearby other security dangers intrinsic in infrastructural and virtual machine perspectives (Hashizume et al., 2012). Variables such as social engineering, programming bugs, and human blunders make the security for cloud a progressively testing one (Kim, 2009). Interruption location is an indispensable job in consistent system checking to decrease security dangers. On the

off chance that the current IDSs (Intrusion detection Systems) are wasteful, the resultant outcome may be undetected security break for cloud condition (Westphall et al., 2011).

Right now, progressing examination and research for incorporated, powerful, and reliable security models for cloud platform could be the main way of inspiration. The unfathomability and possibility of cloud computing can't be ignored, therefore refined security models for distributed computing situations is the most organized factor for an effective cloud based foundation improvement and arrangement.

2.6.2 Software and Application Interoperability

Interoperability problems have for some time been examined in the conventional ways to deal with the IT in construction (Froese et al., 2000). Unmistakably, interoperability problems present themselves in various structures both at information and data levels as well as the system (see figure 2.1). The dotted arrows show information interoperability to help cross-portrayal combination of uses and the solid arrows indicate software interoperability to support connectivity among applications. In spite of the fact that product engineers have started offering explicit undertaking joint effort administration for the construction industry including archive and drawing the executives, contract the executives, and acquirement the board (Beach et al, 2013), notwithstanding, they utilize their very own exclusive document groups. While the capacity to import/fare to institutionalized arrangements, for example, the Industry Foundation Classes (IFCs) is potential, issues still exist with information interoperation encompassing this, for example complete mapping between entirely unexpected configurations isn't achievable in light of the utilization of restrictive expansions. Various principles might be used in isolated cloud stages and conditions, either private or open mists. In this manner, the interoperability

issue in a distributed computing model is increasingly advanced in setting. There is however, currently, a drive to move towards a standardised format and overcome these constraints.

According to (Kumar, Cheng, & McGibbney, 2010), it can be summarized that there are four categories to the cloud computing interoperability issue (figure 2.2). First, interoperation between software's ought to give access on the inside of a single model cloud. Semantics alignment of the data exchanged is required among the applications as well as connectivity of the software's. Second, software's ought to be able to exchange data and information and trigger operations across totally different cloud environments. It is a difficult assignment inferable from the different gauges and setups utilized in independent cloud conditions. Third, programming programs should almost certainly associate various cloud situations and to coordinate data, information and applications crosswise over mists in a brought together way. In this way, cloud situations that are unbiased to operating systems and programming languages cation starting with one cloud condition then onto the next should be sped up. The components that upgrade versatility of cloud applications are presently a functioning examination zone.

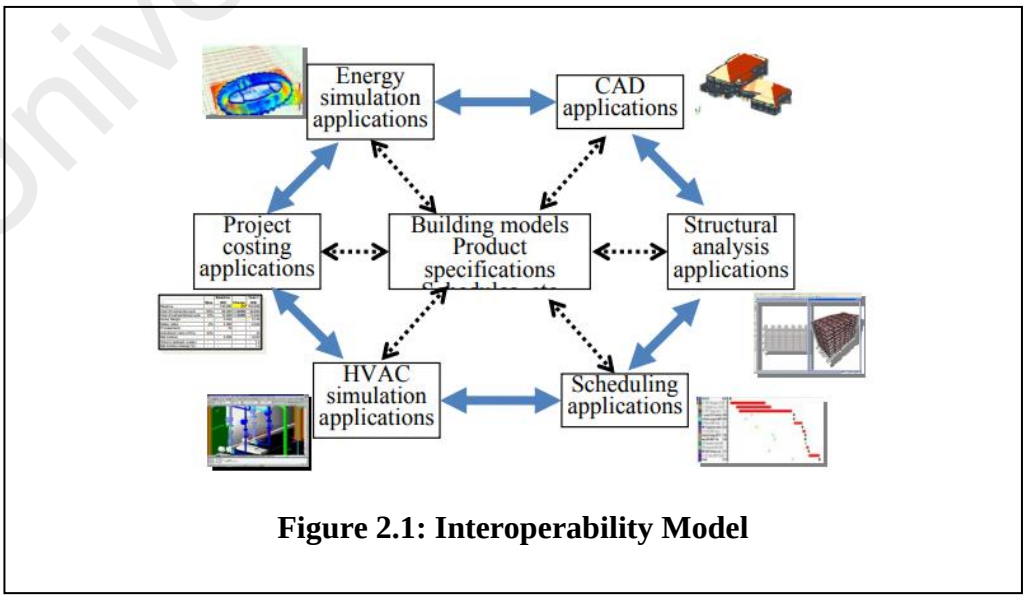

Figure 2.1: Interoperability Model

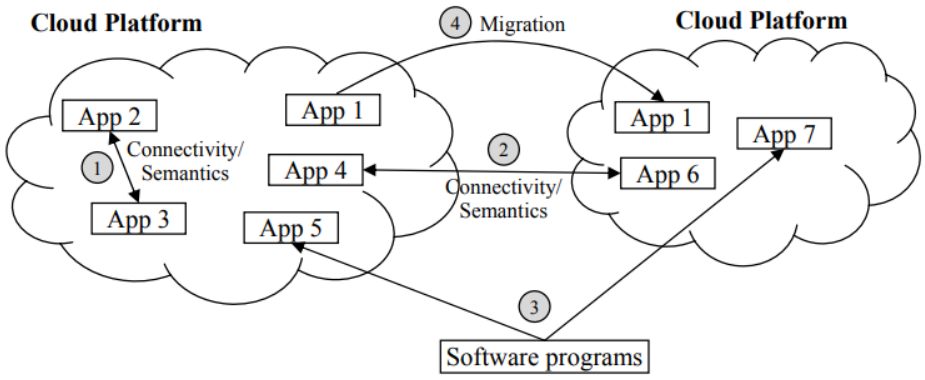

Figure 2.2: Interoperability Issue

To overcome this challenge according to Barara (2014), it is imperative that industry guidelines must be created to help cloud specialist developers co-ops plan interoperable stages and empower information movability. Organizations need to consequently arrangement administrations, and work with both enterprises based and cloud-based applications by utilizing a solitary component that can work over several cloud providers together with existing projects. For this situation, there is a necessity to have cloud interoperability, and endeavours are now under approach to tackle this issue. For instance, Open Cloud Computing Interface, which would give an API to overseeing diverse cloud stages is being worked on by the Open Grid Forum, an industry group. As of recently it has remained a troublesome and testing task in cloud computing.

2.7 Critical Success Factors for Cloud-Based Platform Implementation

It is a complex exercise in technology innovation and organizational change management to implement a cloud platform, (Markus & Tanis, 2000; Kumar et al., 2002) furthermore, it's anything but a simple undertaking. It needs a close participation of staffs, directors, IT experts, business examiners, advisors, and subcontractors and the coordination of

numerous activities of an organization (Sambamurthy and Kirsch, 2000). Besides, the cloud platform adoption contrasts from the conventional framework's adoption in unpredictability, client's interest, organizational effect, scale, business impact and cost (Grabski and Leech, 2007). Also, there is an absence of demonstrated logical hypotheses and encounters on the execution of cloud platform by the construction industry.

All of this has generated a necessity for research on the adoption of cloud platform in construction management. Identifying the factors that determine the success of the implementation of cloud platform in construction management has become an important challenge. Critical Success Factors (CSF) is the regions and activities which ought to be centred around basically so as to pick up the most fulfilling aftereffects of the cloud platform execution (Ziemba and Papaj, 2012, 2013). This research is sure that the hypothesis of critical success factors gives great reason for expressing what criteria ought to be pursued amid cloud platform adoption.

There are a few meanings of basic achievement factors in the writing. Leidecker and Bruno (1984) have represented CSFs that so as to influence achievement elements of an association contending in a particular industry, a set of variables, characteristics, and conditions should be adequately managed, sustained, or maintained. Rockart and Bullen (1981) have characterized the basic achievement factors as the confined number of fields in which positive result will result in "successful competitive performance" for a representative, hierarchical unit, and an association all in all. The CSFs, as indicated by Ramaprasad and Williams (1998) ought to be utilized in three critical territories including data frameworks execution (49.21%), necessities (47.62 %), venture the board (63.49 %) (Ramaprasad and Williams, 1998; Alaskari Ahmad, Dhafr, and Pinedo-Cuenca, 2012).

Cloud platform is still relatively new and so research on the CSFs for cloud platform implementation in construction, have not yet been popularized. However there have been

several recognized studies and research on cloud platform implementation and have characterized the basic achievement factors that influence the adoption of cloud platform in organizations (Rahimah K. et al, 2016; Abdollahzadegan et al, 2013). Table 5 outlines the chose basic achievement factors for cloud platform execution that are referenced in the literature review. Basic examination of those recommendations has enabled this study to recognize the most significant CSFs for cloud platform execution. They incorporate construction management issues and top administration support. Additionally, cloud stage usage must be overseen by experienced and all-around qualified venture administrators. Clear objectives, business analysis, effective communication between the project partners and change management are also equally important. Below we critically discuss the main CFS in cloud computing implementation and adoption.

2.7.1 Top Management Support

Literature by Lin (2010) has considerably acknowledge Top management support in the IT systems. The study by Lin (2010) focus on the understanding of top management to support the implementation of cloud computing and its importance, as well as their involvement in cloud adoption. Participation and involvement of top management, for example the CIO and CEO, cloud computing has been important to a degree with committing resources and managing IT. Zheng et al. (2013) found that the intention to adoption of the technology was led by the significant and positive influence of financial and IT human resource allocation by top management. In ensuring education and training needs to utilize strategies and manage expectations for cloud implementation, building strong ties and employees needs should be assessed by top management essentially. Cloud computing adoption institutional pressures effect is mediated by a higher top management support.

2.7.2 Technical Readiness

IT human resource and infrastructure encompasses technology readiness. According to Wang et al. (2007), IT applications related to cloud computing implementation skills and knowledge are provided by the IT human resource. On the other, building the cloud computing applications platform is to be provided by enterprise systems and network technologies installed which referred to as technological infrastructure. Hence, for implementation of cloud computing, technology readiness of higher degree leads to the organization being more prepared.

2.7.3 Size of Organization

Size of organization or firm size is one of the determinant factors studied in the scientific approach. Innovation implementations is associated with greater risk, and can be taken by bigger firms has an advantage by having more developed technology and more resources, than smaller firms. Hence, the innovative technological development of adopting cloud computing is contributed by a crucial feature such as firm size (Low et al., 2011). While benefits of utilizing services by cloud is derived considerably by organizations, utilizing advantage of the benefits relies on the organization's nature and size. All organizations may not be suitable for one service model. As an example, one type of cloud service may benefit the early stages of growth of an organization, and with development, may need other type of service models. With less authority and fewer resources in the IT infrastructure supply and purchase, a market development was led by small and medium-sized enterprises (SMEs), thus these organizations gain major benefits from the cloud technology "pay-per-use" model. Capability of cloud adoption for larger organizations with more resources however is in contrast to this.

2.7.4 Data Security & Privacy

When a particular technological innovation involves an interaction online, there are bound to be issues as important as privacy. In the world it could be anywhere that an information being stored and accessed by other users in the cloud, and this reflects consumers concern in cloud environment (Vanessa, 2014). It can be said that users do not control or own cloud services where data is uploaded and entered for. It was indicated by Abadi (2009), that, "Computer power is elastic, but only if the workload is parallelisable ... data is stored at an un-trusted host ... data is replicated, often across large geographic distances", which indicates that risk are a cloud technology characteristic. Because of the open nature of the internet, ICT technologies has seen a lack of uptake factored by privacy (Featherman and Pavlou, 2003). Businesses sees privacy as a major concern typically when considering cloud computing (Aziz, 2010; Hailu, 2012). Data theft, data loss, data misuse, and data damage are huge risk when privacy policy is not in place when personal data is transferred to a third party. Risk is minimised by policies being supported by associated controls, but risk remain although policies are in place (Ko et al., 2011).

In cloud adoption, the most significant barrier was found to be information security concerns, as shown by recent study adoption (Armbrust et al., 2010; Kshetri, 2013; Xiao & Xiao, 2013). According to Friedman & West (2010), resilience, assurance, accountability, integrity, availability and confidentiality of information are the information security's base foundation. A number of researchers have discussed cloud computing security issues in general (Jamil & Zaki, 2011; Kshetri, 2013; Zissis & Lekkas, 2012) and with specific reference to SMEs (Adam, 2014; Alshamaila, 2013; Gupta et al., 2013). Many users remaining away from cloud adoption was demonstrated due to security to be a major challenge by several studies (Gens et al., 2009; Shaikh & Haider, 2011). Service disruptions, outside attacks, malicious insiders (Behl, 2011), data security, data

availability, data transmission and data location (Mahmood, 2011) are major data security issues in the environment of cloud computing. Confidentiality that is delegated and integrity and availability of data given to third party are other major challenges. The virtualized resources multi tenancy is the cause of complication in cloud computing security. It was understood by users that the security issues are simplified in cloud computing by having the responsibility outsourced to a presumed highly skilled third party. It was stated by Bhayal (2011) that among clients of cloud computing, concern on the security is the most important, reliability of the data host cannot be considered as where the data are stored is unaware by the data owner.

2.7.5 User Awareness

In cloud computing, among major factors that has affected its adoption is the level of knowledge of staff and decision-makers (Ali et al., 2015; Akar et al., 2016; Dahiru et al., 2014). Due to decision-makers being unaware of implementation factors had sometimes led to time consuming processes when adopting cloud technology (Ali et al. 2016). Therefore, critical role is to be played by staffs and decision-makers with cloud adoption related decisions by improving awareness and knowledge. Awareness and knowledge of staffs and decision makers should also be the advertisement focus of service providers (Ismail et al., 2016). Among the most effective strategies to raise the awareness of managers and staff about new technologies is activities such as obtaining permits as well as offering training on cloud technology implementation (Dahiru et al., 2014; Raza et al., 2015).

2.7.6 Regulatory Environment

In the cloud technology field, political decision and support from the government are two influential factors considered. Cloud adoption is facilitated by governments enacting laws (El-Gazzar, 2014). In contrast, compliance can be a barrier to cloud adoption (Noor, 2016; Opala, 2013; El-Gazzar, 2015). Even with the availability of laws related to cloud in developed countries, sometimes they are in contradiction, moreover cloud technology legal frameworks is also not available in developing countries (El-Gazzar, 2014). For service providers, it has proven to be an obstacle to adhere in accordance with customer countries laws. In the implementation of cloud, negative and positive impacts can be exerted by the government. Influential figures such as ministers may lead to promotion of growth for cloud technology, while negative impacts exerted by focusing on major ICT project failures as well as data security. Cloud adoption can be positively impacted by government to be modernized due to political decision (Kuiper et al.; 2014). Turkish government is a good example, where by with the help of political effort by both the private sector as well as the government in its decision to have its technical infrastructure upgraded (Guner and Sneiders, 2014). Undoubted benefit is to be received by organizations if specific rules are enacted for cloud technology. However, because of data sensitivity, in relation to the storage, dissemination and transfer of data into the cloud, by having approval and assurances supported by the government, sector stakeholders should address the field related the laws.

2.7.7 Compatibility

The ability to be compatible with an existing or possibly future IT infrastructure of an organization is one of the factors to successfully adopt cloud technology. Minimal

adjustments and customizing needed to be made while adoption if available infrastructure is compatible with the cloud service. It is beneficial when selecting the service type of cloud, that compatibility is addressed. Localizing deterrents and possible issues must be adjusted during the first phases of release. By doing so will ensure that the IT section will be easily integrated by new applications.

Thus, compatibility must be addressed when selecting cloud services. In the early phase of deployment, possible errors and malfunctions should be localized and, if necessary, adjusted. This ensures the seamless integration of new applications into the IT landscape (Munzl et al., 2015). The effect lock-in reduction due to less dependence to the service provider because of data portability can be deemed a factor of criticalness for organizations adopting cloud service. Data portability is also a critical factor for companies when using cloud services, as it reduces dependence on the CSP and thus lessens the lock-in effect (Shirm et al. 2015).

2.7.8 Perceived Industry Pressure

The probability of implementing new technology is increased in a competitive environment (Thong, 1999), because the rate and need of implementing new technology will be increased by an uncertain market situation. Typically, competitive pressure is what is described when implementing new innovation is affected by elements of the market environment (Iacovou et al. 1995), which was identified as an element of criticalness when smaller organizations intends to implement new innovations.

Calculated commitments that is made by organizations is greatly impacted by a competitive environment (Porter, 1991). The decision on adoption and integration of new technology is play by an important role such as the element of the environment (Kimberly

& Evanisko 1981; Kwon & Zmud 1987). For instance, a competitive edge is gained by most competitors which has adopted new innovation, leading to an organization integrating the innovation.

2.7.9 Budget & Cost

Organizations can benefit in cost savings led by cloud technology implementation. However, it was proven by several researches that one of the deterrents in implementing cloud technology is cost (Masiyev et al., 2012; Public CIO, 2009). One of the reasons could be that the organization does not have existing infrastructure to implement cloud adoption. This leads to increased budget cost, in addition to training and the need to hire new staff. This could also tie to the firm size mentioned before, where by small firms is unlikely to adopt new innovation, due to smaller budget. Bigger firms have the ability to invest and absorb initial cost, and benefits in cost reduction in management and processes it in future due to an efficient cloud technology adoption. Discussions have been made in above subchapter about the cost benefit of cloud, which is why cost is such a critical factor for successful implementation.

2.7.10 Project Complexity

The varying extent of complexity and scope of the project, as it ranges in project size from major to small, in addition to their location of execution, their place of implementation plays significant positions in the management of issues faced by the organizations, environment, and so on. Additionally, growth of IT environment, for example, internet use to permit works of project team remotely, while provisioning

services in management of project with cloud computing as a substitute than acquiring the services somewhere else. Furthermore, the raising request for project managers, skills of members of the project team, and finally, the application diversity that could be utilized for any project (Sloniec, 2015). Improved project management application is notably affected by the implementation of cloud technology by performing and managing project undertaking; project undertaking and implementation is accelerated by way of having project personnel access to cloud services.

Cloud technology is able to assist companies to surpass project management issues, for example, investment of infrastructure, cost of operation, reiteration needs of clients, location change of customers, issues of resource sustainable, innovation of technology, trends of the market, and many others (Reddy and Chandra, 2012). In addition, huge and complex project is also supported, participation of team members is improved, and allows for access of real time project management application with web based tools equipped. Nevertheless, benefits of utilizing cloud technology could not be gained by all projects, mainly, minor project with minimal financial resource. They are affected by several factors such as not available infrastructure and lack of trained staff (Sloniec, 2015). IT systems and applications applied to assist operational management of complicated and critical project, is acknowledge as significant enablers of project management efficiency. In that sense, information sharing and communication between stakeholders of the project is amplified where project management implements cloud technology as addition to integrate project management with business processes.

2.7 Established Cloud Platform Implementation Guidelines

Due to the known advantages of implementing a cloud-based platform, several countries have established policies for the government sector. According to Seo et al (2014), the most active countries for government-led implementation and establishment of the cloud system are Japan, Australia, Singapore. These countries focus on cloud computing as the solution for the efficiency of the electronic government, ICT efficiency, cost reduction and business innovation. Through cloud implementation in the public sector, these countries are expecting positive effects such as qualitative improvement, budget reduction, enhanced IT infrastructure, increased efficiency of services and development of IT. The implementation of public, private and community cloud is also gradually promoted by the United States of America (USA) where the federal government is concentrating on scalability, cost reduction and ICT efficiency factors as provisions of the cloud promoting goals of the government organizations. The USA has also established the Federal Cloud Computing Initiative (FCCI) in March 2009, which is the initial policy of the Obama government on IT-based integration of federal governments and public institutions and the implementation of CC services (Seo et al, 2014).

BSA's 2018 Global Cloud Computing Scorecard (a study that assesses cloud computing policies around the globe), Malaysia ranks 14th out of 24 leading information technology (IT) economies, compared with 13th in 2016, a sign that the legal and regulatory environment for cloud computing in this country should be improved. Compared regionally, Japan is ranked second, Singapore is ranked sixth and Thailand is ranked 19th.

According to the study, the increasingly adopted technology powers global businesses and helps governments better connect with their citizens on a daily basis. Consequently, countries with policies that promote cloud computing services will increase their productivity and advance their economy.

2.8 Conclusion

In conclusion, literature review represents an important chapter for this research project because with the help of the latest articles I could review my research questions. From the analysis of the literature, I found that cloud computing is playing an important role inside companies, because by using the services applications offered by the cloud platform the company may regain great benefits such as significant cost reduction. Coordinated knowledge management and improved information management provided by cloud platform are also important and may in turn help companies to grow on the market and become more competitive.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

This chapter describes the materials as well as the research methodology used to collect and analyse data required to address the research questions in the study. The sub-topics for this chapter include the research design, and the research procedures adopted. Furthermore, it will also, where appropriate, indicate sampling methods, research instruments and statistical methods employed. The purpose of this is to inform the reader on the methods used to collect the data and generate the findings for the report.

3.1.1 Context of the Research

Cloud computing is recognized as the foundation of a digital revolution for the construction industry. It enables the industry to take advantage of the latest technology and underpins all the most powerful software solutions for design, information management and coordination. Not only has this, adopting the cloud platform in the construction industry had strong appeal because of the frequent setup of new jobsite locations and a constant change of site personnel. Construction professionals and workers need better access to company data to aid in well-supported decision making, and reporting while working in the field.

The goal of our research was to propose strategies for a successful implementation of cloud platform in construction management by exploring the critical success factors. These are complicated subject matter and that they need require analysis tasks of cognitive, methodological, and utilitarian characteristics. Such a broad scope of work

involves adaptation of research methods to specific individual tasks and requires the use of different research instrument, allowing for clarification and verification of results.

As such, so as the research aim can be achieved, numerous techniques and methods of science shall be applied, such as a critical analysis of literature, case study, as well as methods of creative thinking and logical deduction.

3.2 Research Design

Research can be described as a systematic and arranged effort to investigate a particular issue to provisupply an answer (Sekaran, 2000). Consequently, its output is to feature new information, develop theories as well as gathering evidence to prove generalizations (Sekaran, 2000). Furthermore, it was defined by Bulmer (1997) that sociological research is a primary commitment to establish systematic, reliable and valid knowledge about the social world. However, Kerlinger (1986) states that a research project could be an empirical, controlled, systematic, and critical investigation of propositions about the presumed relationships between various phenomena.

Research is classified into three categories: mixed method, qualitative, and quantitative research (Creswell, 2008; Cohen et al., 2007; Gliner et al., 2009). According to Smith et al., (1979), quantitative research employs the conventional, the positivist, the experimental, or the empiricist method to enquire into an identified problem. Quantitative is based on testing a theory, measured with numbers, and analysed using statistical techniques and it particularly emphasizes objectivity and reproducibility (Smith et al., 1979). Meanwhile, Fraenkel & Wallen (2003) argued that the goal of quantitative strategies is to work out whether or not the predictive generalizations of a theory hold true. Thus, quantitative approach is additionally concerned with problems with what

quantity, how well, or to whom that exact issue applies. Kerlinger & Lee (2000) explained that quantitative approach is deductive in nature, and that researchers make inferences based on direct observations with the primary goal to describe cause and effect.

A study based upon a qualitative process of enquiry has the goal of understanding a social or human problem from multiple perspectives (Denzin & Lincoln, 2000). Thus, qualitative researchers deploy a wide range of inter connected interpretive practices, hoping always to get a better understanding of the subject matter at hand. Additionally, they conjointly explained that qualitative approach is conducted in a very natural setting and involves a method of building a complex and holistic image of the development of interest as well as being inductive in nature. A researcher conjointly delves into the problems of interest exhaustively and in detail. Mixed methods approach meanwhile is a combination of quantitative and qualitative approach. The research methodology primarily constitutes the research design and research process, sampling, data collection and method of analysis (Gill & Johnson, 1997; Sekaran, 2000). The research design and process are briefly outlined in the subsequent sub-sections.

As indicated by Kumar (1999), a research design is a procedural plan that is used by researchers to answer questions objectively, accurately, economically and with validity. A conventional research design is a blueprint or an elaborative set up of how a research study is to be completed; selecting a sample, collecting data, operating variables for measurement and analysing the results of interest to the research, and testing the hypotheses (Thyer, 1993). In the simplest sense, the design is a logical sequence that connects the empirical data, research questions and conclusions. Bryman & Bell (2007) stressed that research design should provide the overall structure and orientation of an investigation as well as a framework within which data can be collected and analysed. Miller & Lessard (2001), and Yin (2002) also present detailed descriptions of the

necessary considerations in designing the research project. Based on their recommendations, the element of this research design should encompass the followings:

i. The research problem and question,

ii. Research design,

iii. Critical analysis of literature

iv. Methods of data collection

Furthermore, it was stressed by Yin (2002) that the foremost purpose of the research design is to help avoid a situation in which the evidence does not address the initial research questions. A research design, in this sense, deals with a logical problem and not a logistical problem. In conclusion, it was described by Rani (2004) that a research design is a blueprint or a plan for action, indicating the approaches and procedures for collecting and analysing the required information, fulfilling the research objectives, and finding the solutions to research questions. Identifying and formulating a problem is one of the foremost necessary aspects of doing research in any field of study. Until a problem is recognized, research cannot proceed (Rani, 2004). The research problem serves as the inspiration and foundation of a research study if it is well developed.

The research process of this study was adapted the research process used by Cavana et al. (2001). It was formulated principally based on addressing the research questions at every phase of this study. The first phase, the factors for success, challenges and barriers to cloud platform adoption in the construction industry were determined through a literature review. In the second phase, through quantitative survey study, as the data collection method, will determine which factor will most likely to have more impact in adopting cloud platform. The third phase of the research process will validate the whole research process, research findings and the research contributions for content validity, as defined by Cavana et al. (2001). Content validity will make certain that the measures include an

acceptable and representative set of items that tap the concept. There are at least three ways to achieve content validity, namely, from qualitative research, from the literature, and from the judgement of a panel of experts. The validation process for this research will be conducted through a structured interview among professional experts, internal and external interested parties, and construction stakeholders.

3.2.1 Critical Analysis of Literature

To explain the nature of construction management, cloud computing definitions, exploring cloud platforms, and identifying critical success factors (CSF) for cloud platform implementation, a critical analysis of literature as well as methods of creative thinking and logical deduction have been used. In order to present the practical dimension of cloud platform implementation, especially CSFs for cloud platform implementation in construction management, action research has been applied. Action research as well as creative thinking and logical deduction helped to define CSFs which are essential in case of managing cloud platform implementation in construction management.

The overall purposes of a literature review were to critically appraise and synthesize the current state of knowledge relating to cloud computing, information systems, and the role of the construction management processes in the cloud platform implementation. Action research is distinguished by a rigorous communication between researchers and subjects. At all stages of cloud platform implementation, the author will have a constant contact with project teams as a participant of the project and is currently adopting cloud platform within project.

3.2.2 How Cloud Platform Impacts an Organization

The research design that has been chosen for this research is the survey questionnaire as it is the best method to obtain and collect valuable responses and data to relate to the objective of the study. A survey research is a study that is conducted by collecting information, responses and data from a representative of a group, which shall represent the overall population and generalized. A survey was defined by McBurney (1994) as a process of assessing a general opinion or individual characteristics from the selected population by obtaining responses through sampling methods and use of questionnaire. For this specific research, the researcher wants to obtain and investigate the Critical Success Factors of implementing a cloud-based application in construction management and its impact to overall project delivery, the development of questionnaire was based on preliminary studies conducted. Secondary data collected are the basis of questionnaire development.

3.3 Data Collection

According to Ayob (2005); Rani (2004) and Sekaran (2000), the researcher should precisely structure the respondents for the research – individuals, groups, and a panel of respondents whose opinion may be sought on the interested issues. Interviewing, questionnaires, and observing people and situations are the three main data collection methods in survey research. According to Cavana et al. (2001), data needs to be collected after the development of the research questions. Data can be collected by using either quantitative (example – surveys) or qualitative (example – interviews) methods.

The methods of data collection in this study, were carried out through a critical analysis of literature in the first phase, a quantitative; structured questionnaire in the second phase.

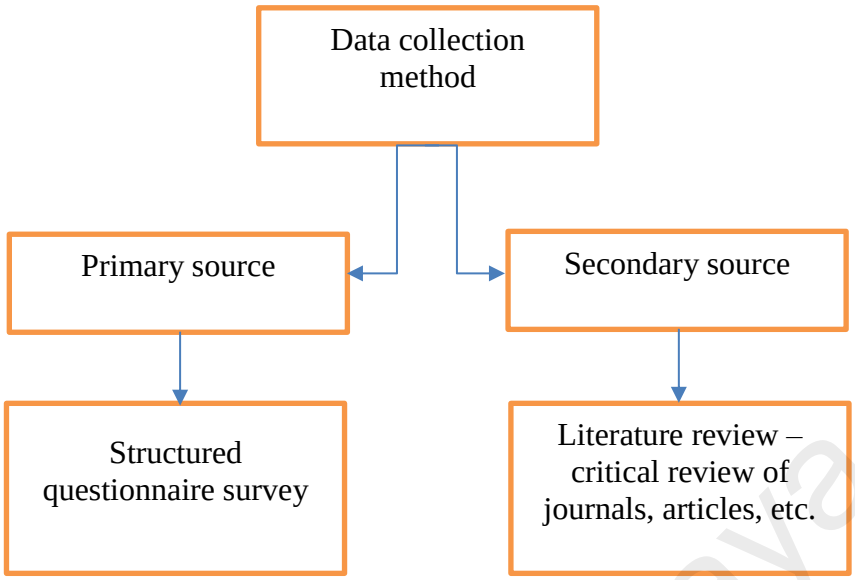

Figure 3.1: Data Collection Flow

3.1 Primary Sources

The primary source data is the data obtained from the first sources, whether through questionnaire, interview or survey for the specific purpose. The literature review is done before come out with the relevant research question that suit to the objectives of the study. Once the researchers clear about the research topic through the literature review, the structured questionnaire can be drafted to continue the research process. The primary data for this research will be obtained from the distribution of structured questionnaires among the relevant parties which only focus for listed company.

The researcher has made a model of data collection based on online questionnaire rather than hand it to the respondent and created in the internet and inviting any respondents associated to complete them. The questionnaire was design mainly to collect the data on experts' opinions on critical level of cloud-based application in construction. Section A of questionnaire consists of the demographic background of the respondent. Section B consists of a set of question related to cloud-based application tools currently used by professionals in construction. Section C consists of structured question to gather information on the Critical Success Factors for adoption of cloud-based application in

construction management in Malaysia. Section D consists of a set of question related to the implementation impact of cloud-based application or tools used in construction project management in Malaysia. The questionnaire consists of a list of assessment element to be ranked by respondents based on critical factors using Likert-scale from 1 to 5. The number represents the critical level of every element in cloud-based implementation. The higher the number represents the higher the critical factors of that element.

This research approach was used because it offers the opportunity to be directly involved with cloud service providers and users. In-depth knowledge about opportunities, risks and challenges of cloud computing with respect to security were gathered through survey questionnaires. The survey provides in-depth information pertaining to participants' experiences and to gather information about awareness of construction professionals on the use of cloud services and the associated security risks and challenges that it presents.

3.3.2 Secondary Sources

The secondary sources of data are the data obtained from the sources such as books, journals or articles which the information has been recorded before. From this source of data, the researchers can spend less money and time in collecting data since the information can simply be derived from information that has been recorded compared to primary data which incurred extra cost of gathering the data. In addition, the secondary sources of data are helpful for the researchers to deepen the understanding of their research field, designing the research question for obtaining primary data and as a comparison for collecting primary data. Therefore, it is important to start a research by reviewing the secondary data. The secondary data in this dissertation are obtained through

the literature review based on the journals, books, articles, newspapers, conference papers and other relevant website.

3.4 Questionnaire Design

The content of the questionnaire was developed based on the literature review done for the related information about the critical success factors and challenges on implementing cloud-based application in construction organizations. In this study, a cover letter is attached to the questionnaire to explain the purpose of this research conducted. the questionnaire structure is based in the objective of this research. Each of the section is organized from the objective on order to be on track on achieve the stated objective.

3.4.1. Section A

Section A of the questionnaire consists of a background of the respondents, which indicate their age, education level, experience, gender and also their current ongoing projects.

3.4.2. Section B

The Section B is where the current industry usage of cloud applications is analysed. This will be answering to the 1st objective.

3.4.3 Section C

Section C of the questionnaire consist of Critical Success Factor elements that has been analyse from literature studies.

3.4.4. Section D

Finally, in Section D consist of the perception on implementation impact of cloud-based application.

3.5 Sampling Method

Sampling is the process or skill of choosing an appropriate sample that is representative to the population taken (Singh, 2007). The researcher is able to save time and money by using samples as the data collected can be almost as precise as those for the whole census of the population being considered in this study, stratified random sampling is adopted. This type of sampling involves assigning the population into homogeneous groups call strata that are based on different indicators such as characteristic or geographical factor. Using stratified random sampling is advantageous if the researcher wants to obtain comparative results between strata. It also declines sampling error as all the groups are concerned by selecting within each stratum. Therefore, the result is more reliable and comprehensive than those random sampling if the characteristic or nature of the population are taking into consideration.

The sample size needed in this study is derived from Public Listed Companies as in the main board for construction & engineering of the Kuala Lumpur Stock Exchange

(KLSE). For this sample size and total population with the confidence level of 95% and 5% margin error. From the Public Listed Companies, there are 49 construction & engineering companies. These companies are selected due to their market capital and capacity to undertake complex projects, as well as having necessary resources to adopt new innovation to gain market advantage over competitors. The companies will nominate 2 employees as representative to provide responses to the survey questionnaire, which will amount the total responses to 98. Table 3.1 below indicates the list companies identified.

Table 3.1: Bursa Malaysia Public Listed Construction & Engineering Companies

1	Advancecon Holdings Bhd	26	Melati Ehsan Holding Bhd
2	AME Elite Consortium Bhd	27	Mercury Industries Bhd
3	Ahmad Zaki Resources Bhd	28	MGB Bhd
4	Benalec Holdings Bhd	29	Mitrajaya Holdings Bhd
5	Bina Puri Holdings Bhd	30	MTD ACPI Engineering Bhd
6	Brem Holding Bhd	31	Mudajaya Group Bhd
7	Crest Builders Holding Bhd	32	Muhibbah Engineering (M) Bhd
8	DKLS Industries Bhd	33	OCR Goup Bhd
9	Econpile Holding Bhd	34	Pimpinan Ehsan Bhd
10	Ekovest Bhd	35	Pesona Metro Holdings Bhd
11	Fajar Baru Builder Group Bhd	36	Protasco Bhd
12	Gadang Holding Bhd	37	Prinsiptek Corporation Bhd
13	Gamuda Bhd	38	Pintaras Jaya Bhd
14	Gabungan Aqrs Bhd	39	Puncak Niaga Holdings Bhd
15	George Kent (M) Bhd	40	Eversendai Corporation Bhd
16	Oriental Bhd	41	Stella Holdings Bhd
17	Ho Hup Construction Company Bhd	42	Sunway Construction Group Bhd
18	Hock Seng Lee Bhd	43	TRC Synergy Bhd
19	IJM Corporation Bhd	44	TSR Capital Bhd
20	Ikhmas Jaya Group Bhd	45	Vizione Holdings Bhd
21	Ireka Corporation Bhd	46	WCE Holdings Bhd
22	JAKS Resources Bhd	47	WCT Holdings Bhd
23	Kerjaya Prospek Group Bhd	48	Zecon Bhd
24	Kim Loong Corporation Bhd	49	Zelan Bhd
25	Lebtech Bhd		

3.6 Survey Administration

The respondents received the questionnaires through several distribution methods such as e-mail, or by any messaging service application in the case where the contact of an identified respondent is available. For e-mail & messaging, pre-delivery enquiries have duly been made. Then, a one-day interval is provided to allow ample time for respondents to complete and submit the completed questionnaire. The respondents therefore had enough time to put across their propositions under a stress-free condition and non-demanding timeframe.

Table for Determining Sample Size of a Known Population

N	S	N	S	N	S	N	S	N	S
10	10	100	80	280	162	800	260	2800	338
15	14	110	86	290	165	850	265	3000	341
20	19	120	92	300	169	900	269	3500	346
25	24	130	97	320	175	950	274	4000	351
30	28	140	103	340	181	1000	278	4500	354
35	32	150	108	360	186	1100	285	5000	357
40	36	160	113	380	191	1200	291	6000	361
45	40	170	118	400	196	1300	297	7000	364
50	44	180	123	420	201	1400	302	8000	367
55	48	190	127	440	205	1500	306	9000	368
60	52	200	132	460	210	1600	310	10000	370
65	56	210	136	480	214	1700	313	15000	375
70	59	220	140	500	217	1800	317	20000	377
75	63	230	144	550	226	1900	320	30000	379
80	66	240	148	600	234	2000	322	40000	380
85	70	250	152	650	242	2200	327	50000	381
90	73	260	155	700	248	2400	331	75000	382
95	76	270	159	750	254	2600	335	1000000	384

Note: N is Population Size; S is Sample Size *Source: Krejcie & Morgan, 1970*

Figure 3.2: Krejcie and Morgan Sampling Method

3.7 Method of Data Analysis

Information gathered from data collection will be used for data analysis to continue the research process of this study. Data analysis is the process of evaluating data gathered using analytical and logical thinking to study each element of data gathered from data collection. Basically, data from primary and secondary sources is assembled, reviewed, and analysed to form some sort of finding or conclusion. The data can be tabulated and presented in the form of pie chart, bar chart or graph for better presentation of the result. There are several methods used to analyse the data collected for this study, which are percentage method and statistical significance. The data collected through questionnaire survey is analysed using Statistical Package for Social Science Research (SPSS) Version 27 as it is a common and powerful tool to analyse data in both descriptive and inferential statistics.

3.7.1 Percentage Method

Percentage method of analyzing data is a typical method that being used which is simple and easy to retrieve data. In this method, the results will be tabulated in the form of percentage (%) for better understanding of collecting data. The data will be recorded in the table forms and interpreted using the graph, bar chart or pie chart which depends on its suitability. This method usually used to analyse respond of respondents when answering the multiple-choice questions such as closed-ended and yes/no pattern question. In order to process the data, the Micro Statistical Package for Social Science Research (SPSS) Version 27 will be used. The percentage is calculated by using the formula as shown in figure below.

3.7.2 Cronbach's Alpha Reliability Test

Cronbach's Alpha is used to measure the reliability of each question by determining the internal consistency in a survey instruments (Cronbach,1951). The results of this Cronbach's Alpha are expressed as a number between 0 and 1. The rule of thumb is the result of Cronbach's Alpha should be 0.8 or above (Bryman & Cramer,2005). However, the score of 0.7 is acceptable for research purposed (Muijs, 2004).

3.7.3 Normality Test

The sample distribution is important to determine whether the parametric or nonparametric test is adopted. If parametric tests are used, there are three conditions have to be followed. The three conditions are the level of measurement is interval or ratio scaling, the sample distribution is normal and the variances of both variables are equal or homogeneous (Bryman & Cramer, 2005). If those conditions are not fulfilled, nonparametric test must be adopted.

3.7.4 Inferential Analysis

The inferential statistic is also known as bivariate statistical analysis. By using this statistic, the sample of higher level can be interpreted and analysed by making conclusion for a large population from the targeted sample at the initial stage. To prevent unbiased decision, the sample must be randomly selected from population, this analysis can be done through result extraction by comparing different parts of the variables.

3.7.5 Relative Importance Index

The primary data collected from part of the questionnaire was analyzed from the perspective of clients, consultants and contractors. The five-point Likert scale to indicate the relative importance of each cause were then transformed into RII perceived by all respondents using the formula below.

$$\text{RII} = \frac{\sum W}{\text{A } x \text{ N}}$$

Where: W – scale for rating a factor (ranges from 1 to 5); A – is the highest weight in the scale; N – is the total number of respondents.

Then causes were ranked based on RII values according to overall ranking and group category. From the ranking assigned to each critical success factors, the study able to identify the most important factors for a successful implementation of cloud-based application in construction management in Malaysia.

3.8 Summary

In this chapter the theoretical and philosophical assumptions underlying the research methodology in cloud platform were reviewed. In addition, a discussion of the research design for this study was made. A critical analysis of literature and a structured survey questionnaire was chosen as the appropriate approach for the qualitative study to determine the factors of successful adoption of cloud platform. Through the active participation of the members who participated in the survey, the researcher will be able to get more input from the stakeholders in relation to the issues raised in this study.

CHAPTER 4: DATA ANALYSIS AND FINDINGS

4.1 Introduction

In this chapter the results obtained throughout the data gathering and analysis process are presented. The data was collected and analysed in response to the problems identified in Chapter One (1) of this research report. Three (3) fundamental objective of this research drove the collection of the data and the subsequent data analysis. The data acquired will be elaborated by using Likert Scale Analysis. The researcher used familiar tool that is Statistical Package for Social Science Research (SPSS) Version 27 in order to acquire accurate result since the tool is simply understood amongst researchers and user friendly. The findings presented in this chapter demonstrate the potential for merging theory and practice.

The analysis was based on the responses received from public listed construction companies organization in the main board of Bursa Malaysia. There are a total 790 public listed company in the Bursa Malaysia, and among these, there are 49 companies categorize in construction and property. The survey was conducted only for those construction and property companies. The result of the survey was acquired after the analysis made. In this chapter the analysis was designed to study the critical success factors in implementing a cloud-based application among organization in the construction industry. This chapter defines the participants in this study and the result of analysis was used to answer the research objectives which are:

i. To investigate the industry utilization for cloud-based tools or application among construction professionals to manage increasing project complexity.
ii. To identify what are the critical success factors (CSF) to implement a cloud-based platform their impact to project success in construction management.

4.2. Response Rate

For this research purposes, the survey data documentation had been collected through online invitation, email, as well as response through online survey forms created. Entirely, the questionnaire surveys had been distributed to all 49 construction-related organizations listed in Bursa Malaysia. In order to increase the response rate, some of the questionnaire that were sent to some organization was followed up. In total, one hundred (100) questionnaires was distributed to respondents, 92 numbers were returned, representing 92% response rate.

4.3 Quantitative Research Result

4.3.1 Analysis of Demographics

The demographic characteristics of the respondents are given in table 4.1. Demographics survey asks potential respondents to provide basic demographic information on themselves and to better understand their characteristics. This survey will provide a multi-dimensional profile of the respondents, lets the researcher be more familiarized with the current trend of the industry. and will provide valuable insight on the overall research finding.

Gender of respondents is an important data to indicate the possibility of respondent in how they make a decision. Mostly, gender differentiation shows differential ability of the respondent in term of resistance of physical and capability Based on the above figure 3, 57.6% from the total respondents are male with a response rate of 53 numbers of participation. The remaining 42.4% are females with 39 response rates.

The age of respondents which it is deemed as an important factor because it can illustrate the level of the maturity of the respondents in their knowledge of construction management and it is related to working experience of the respondents in the construction industry. It also provides an overview of which age group is more inclined in using a new technology and show their ability to adapt to current innovations.

Most of the respondents are in range of 25 to 30 years old with a response rate of 35 respondents or 38% which indicate this age group has a lot of interest in current technology. 30.4 % or 28 response rates for age range of 31 to 35 years old, while the age range of 36 to 40 years old is 21.7% or 20 respondents. Age range of 41 to 45 years old has 7 respondents or 7.6% and age range of more 45 years old has been represented by 2 respondents or 2.2 %. This just shows that this age group does not utilises cloud-based application as much as the younger group of respondents.

The next analysis is the education level of the respondent's, where the average outcome of the overall analysis of the research will be able to be tied back to the level of education the respondents received, as well as the level of skill and knowledge that they have. Furthermore, the data obtained from questionnaire survey on the level of education will give a general view of the organization on the capabilities of the respondents in order to facilitate the work and ensure project is undertaken by people who understand and have knowledge on the roles they assume at their respective organizations.

From the data gathered in the survey, the data completely shows all 93 respondents possess at least a recognized qualification. The highest respondent of 67.4% or 62 respondents possess a bachelor's degree. Master's degree holders account for 29.3% or 27 respondents. This is probably due to the fact that most of the master's graduates prefer

to further their studies and eventually became academicians rather than work as engineers or executives of construction firms. Degree holders also often jump straight and start their career due to its financial attraction hence contributing to the high respondents of this education level. Diploma level respondent are the lowest in ranking compared to degree and masters with only 3% or 3 numbers of respondents. This is quite expected due to the nature of work as Diploma holders being more involved with the physical work in construction and less involved in management and engineering part of the organization. Education level is deemed as necessary in strengthening analysed data as it influences and often reflects the knowledge and understanding of construction management.

It was stated by Boyatzis (1982) that through experience and formal education, the knowledge gained in both leads to an increase in competence level, which is widely accepted. Furthermore, this knowledge must be gained at both the individual level and the organizational level (Gareis & Huemann, 2000). The following analysis is one of the crucial factor in analysing the success of implementation of new innovations, which is about work experience of respondents in construction management. This is deemed as a vital analysis in strengthening the overall data that is analysed. The more working experiences a respondent has in construction industry, the more possible outcome they can envisage and the more mature is seen in making decisions that could lead to a successful project delivery.

The survey result based on table 4.1 shown that most of the respondents have experience in range of 5 to 10 years with 35.9% or 33 respondents. This is then followed by 31.5% or 29 respondents have an experience of less than 5 years, which is deemed as entry level experience period they achieved in construction field. Further, it is followed by the respondent's group of 10 to 15 years working experience, which is absolutely deemed as

in a good experience period. There are 17 respondents or 18.5% in this experience group These three experience group is a crucial respondent's group as they represent the next generation of industry professionals and are more involved with utilizing new technology in order to manage more complex projects in the coming years. 15 to 20 years of work experience is represented by 11 respondents or 12%, while experiences of more than 20 years are represented by 2 respondents or 2.2%. These two experience group are crucial in providing feedbacks as well as making calculated and mature decisions in the face of change management which contributes to a successful implementation of new innovations. They also act as leaders and represent the top management group, furthermore will have influences in the industry that could be crucial in ensuring project success.

For the analysis of respondent field of organization, project management represented by the most respondents which is 38% or 35 respondents. This is followed by contractor which is 35.9% or 33 respondents. Consultant role is represented by 21.7% of the responses, or 20 respondents. Other respondent represents architect, which is 2 respondents or 2.2%, and client and designer which is 1.1% or 1 respondents each.

The field of professions represents obtained data on the occupational role of the respondents. This data gives the researcher a clear overview of the overall profession which utilizes cloud-based application/services more in helping them manage project deliverables. An engineer represents the highest group to utilize cloud technology, with 45 respondents being an engineer by profession, or 48.9% overall. This group overshadows the following group by a huge margin, which is 17.4% or 16 respondents represented by project managers. This is expected as engineers is seen as the driver group in an organization to utilise new innovations and technology to assist them manage their

increasingly complex task. Health, safety and environment executive is represented by 15 respondents, or 16.3%. Architect is represented by 6 respondents, or 6.5%, followed by quantity surveyor with 2 respondents or 2.2%, and BIM coordinator, event manager and interior designer, represented by 1 respondent or 1.1% each.

The number of employees in an organization has always reflect the magnitude in size of the organization. One of the crucial influences to an organization's capacity has often described by the size of the organization. Size of an organization (as defined by the number of employees) has received substantial attention from researchers and management writers as a fundamental component affecting organizational design, structure and shape. Effectiveness of an organization and its efficiency could also be influenced by its size as claimed by some researchers claim, although sometimes it does not. Of the various structural variables, size is perhaps the one most likely to be associated with other organizational characteristics (Shin and Suh, 1999, Hofler, 2010).

The final analysis for demographics is on the employee size of the respondent's current company. A large number of respondents are from employee size of more than 400, which is 57 respondents, or 62% over overall respondents' group. This is expected as the sample target of this research is from the public listed construction company from the main board of the Kuala Lumpur Stock Exchange (KLSE). Respondent group of 300 to 400 represents 12%, or 11 respondents. 200 to 300 respondent group represents 7%, or 6 respondents, while 100 to 200 group is represented by 4.3% or 4 respondents. The less than 100 employee group is represented by 14 respondents, or 15.2%.

Table 4.1: Demographic characteristics of respondents

Demographic characteristic	Frequency	Percent %
Gender		
Male	53	57.6
Female	39	42.4
Age		
25 - 30 years	35	38
31 - 35 years	28	30.4
36 - 40 years	20	21.7
41 - 45 years	7	7.6
45 years and above	2	2.2
Highest Education		
Diploma	3	3
Bachelor Degree	62	67.4
Master's Degree	27	29.3
PhD	0	0
Work Experience		
Less than 5 years	29	31.5
5 – 10 years	33	35.9
10 – 15 years	17	18.5
15 – 20 years	11	12
More than 20 years	2	2.2
Field of Organization		
Project Management	35	38
Contractor	33	35.9
Consultant	20	21.70
Architect	2	2.20
Client	1	1.1
Designer	1	1.1
Field of Profession		
Engineer	45	48.9
Architect	6.5	6.5
Quantity Surveyor	2	2.2
Project Manager	16	17.4
Executive	5	5.4
Health, Safety & Environment	15	16.3
BIM Coordinator	1	1.1
Interior Designer	1	1.1
Employee Size of Current Company		
Less than 100	15	15.2
100 - 200	4	4.3
200 - 300	6	7

300 - 400	11	12
More than 400	57	62

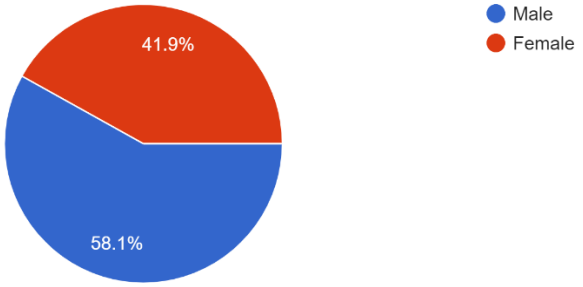

Figure 4.1: Gender

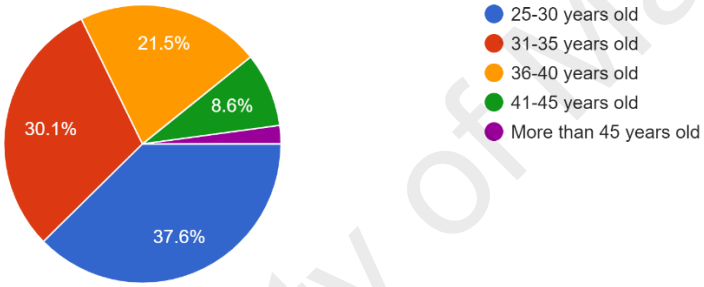

Figure 4.2: Age

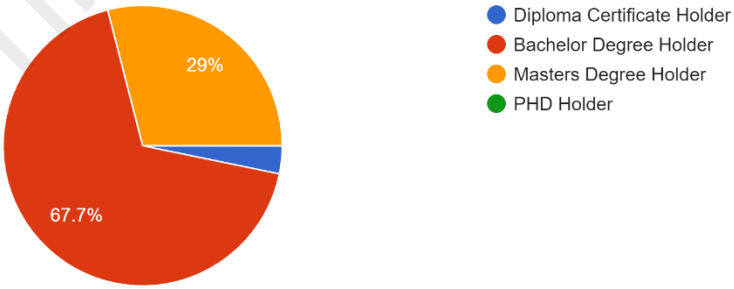

Figure 4.3: Highest Education

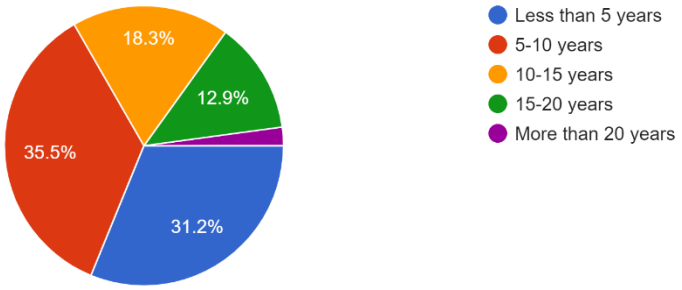

Figure 4.4: Work Experience

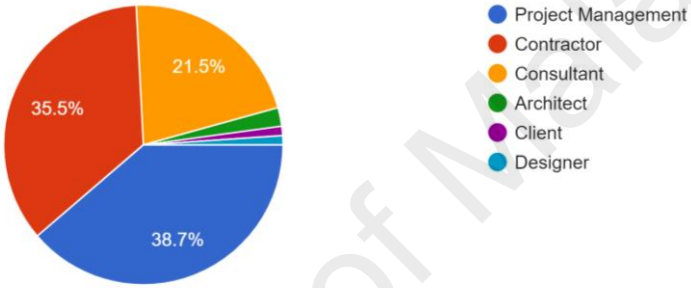

Figure 4.5: Field of Organization

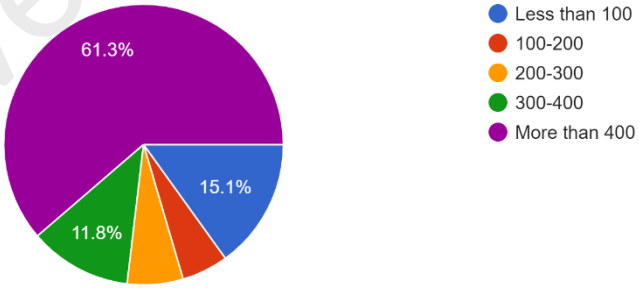

Figure 4.6: Employee Size of Current Company

4.3.2 Analysis on Utilization of Cloud-Based Application/Service Among Industry

The primary data collected from section B, C & D of the questionnaire was analysed from the perspective of industry professionals such as consultants, contractors, project manager, and so on. Each individual factor's RII perceived by all respondents was computed for overall analysis.

The result of the generated output is shown in table 4.2 from the five Likert scale from "5 = Always, 4 = Often, 3 = Sometimes, 2 = Rarely to 1 = Never". Results in Table 4.2 indicate the overall ranking of four (4) most used cloud-based application and services which are: (1) File Sharing/Storage (RII = 0.589); (2) Documentation Management (RII = 0.0.565); (3) Project Management (RII = 0.400); (4) Building Information Modelling (RII=0.300). The survey also indicated that 62% of respondents believed that cloud-based application/services is reliable.

From the tables below, the results of the survey give further understanding on the overall industry utilization of cloud-based application/services among construction professionals. It highlights that current industry highly utilizes cloud applications/service to help them manage project effectively and efficiently. However, as highlighted in Chapter Two (2), implementation of cloud-based application/service has its own challenges. It is a complex exercise in technology innovation and organizational change management to implement a cloud platform, (Markus & Tanis, 2000; Kumar et al., 2002) Thus, identifying the factors that determine the success of the implementation of cloud platform in construction management has become an important challenge.

4.3.3 Analysis of Critical Success Factors on The Implementation of Cloud-Based Application/Service

The results of critical success factors in adopting a cloud-based application/services in construction projects are presented in Table 4.3 categorized by ten (10) major categories: top management support, technical readiness, size of organization, data security and privacy, user awareness, regulatory environment, compatibility, perceived industry pressure, budget and cost, and project complexity. The critical success factors are identified as independent variables in this research. The major categories are further broken down into three sub factors each. This gives a total of 30 sub factors. The result of the generated output is shown in Table 4.3 above from the five Likert scale from "5 = Strongly Agree, 4 = Agree, 3 = Neutral, 2 = Disagree to 1 = Strongly Disagree". Relative Importance Index (RII) was then being ranked by (1) comparing with critical success factors and (2) factor category.

Result in Table 4.3 indicate that the ten (10) most important critical success factor for implementation of cloud based application or services in construction management were: (1) Top management to drive change for adopting new innovations (RII = 0.713); (2) Top management awareness has a beneficial relationship to adopt an innovation (RII = 0.702); (3) Network connectivity, broadband, fiber optic connectors, and electrical power supply are crucial for cloud implementation (RII = 0.702); (4) Top management response is important to implement new innovation (RII = 0.696); (5) Knowledge and experiences of IT human resources is crucial (RII = 0.674); (6) Having a powerful infrastructures feature among the major criteria for cloud adoption (RII = 0.670); (7) Competition increases the likelihood of innovation adoption (RII = 0.654); (8) Advantage is acquired only of new system has proven benefits than conventional methods (RII = 0.654); (9)

Adoption is viable if it helps with managing complex project (RII = 0.650) and (10) Employee negligence are significant security threats (RII = 0.643).

Table 4.2: Ranking of Cloud- Based Application/Service

	Type of Cloud Service	Percentage of respondents scoring					RII	Overall Ranking
		1	2	3	4	5		
1	How often do you use cloud-based Project Management tools/services?	28.0	8.0	11.0	42.0	11.0	0.400	3
2	How often do you use cloud-based File Sharing/Storage Tools?	5.0	2.0	12.0	53.0	27.0	0.589	1
3	How often do you use cloud-based Documentation Management Tools?	9.0	3.0	3.0	66.0	18.0	0.565	2
4	How often do you use cloud-based Building Information Modelling Tools?	39.0	8.0	27.0	16.0	10.0	0.300	4
5	How do you rate the reliability of Cloud-Based Tools?	1.0	0.0	12.0	62.0	25.0	0.620	-

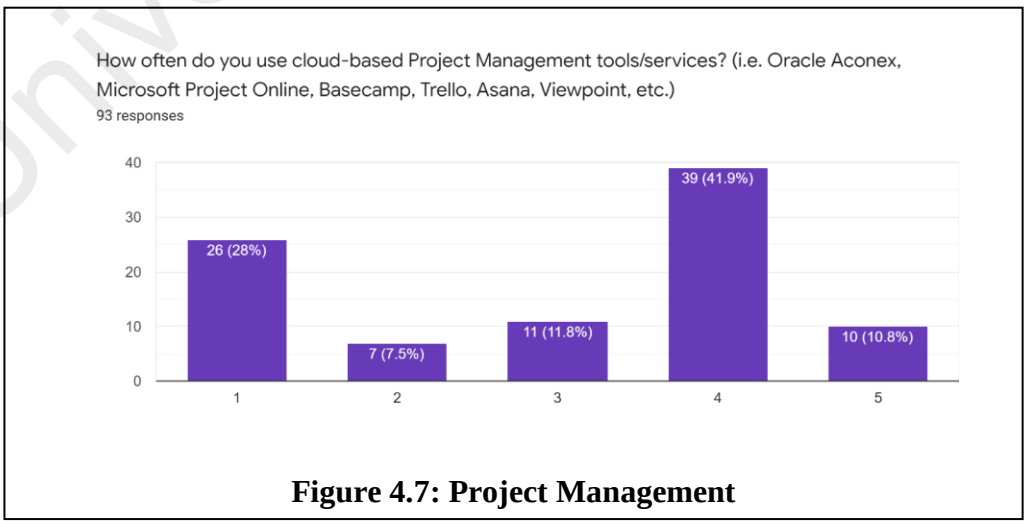

Figure 4.7: Project Management

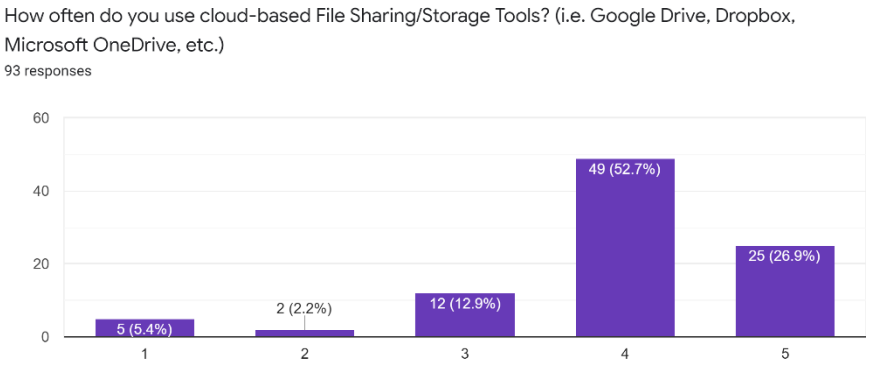

Figure 4.8: File Sharing/Storage

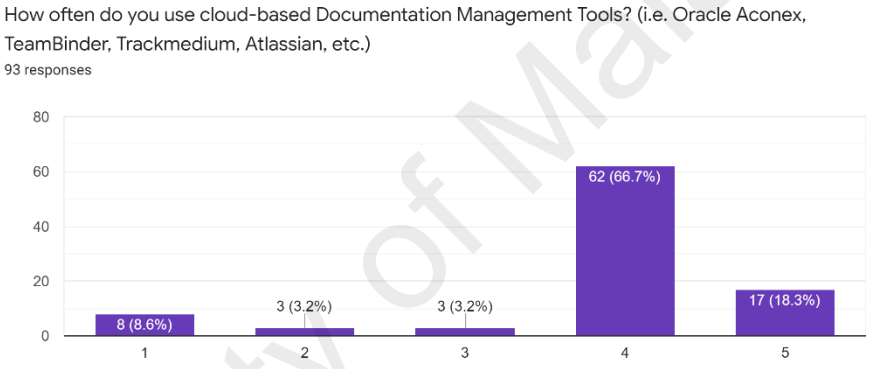

Figure 4.9: Documents Management Tools

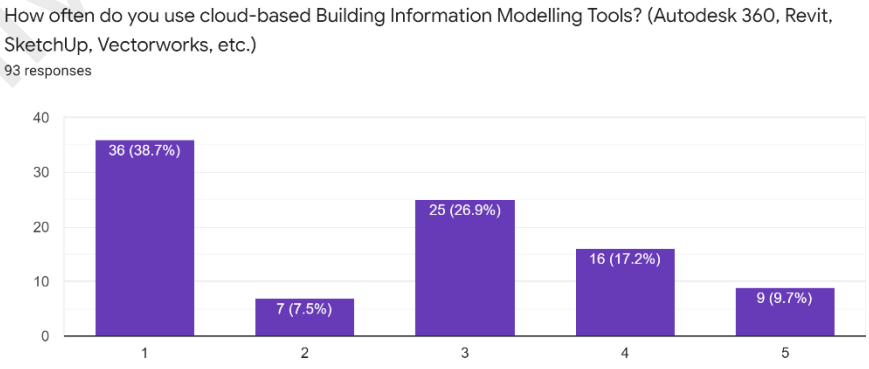

Figure 4.10: BIM Tools

Table 4.3: Ranking of CSF based on overall and category

	Cause of delays	Percentage of respondents scoring					RII	Overall Ranking	Category Ranking
		1	2	3	4	5			
	Top Management Support								
1	Top management awareness has a beneficial relationship to adopt an innovation	1.0	0.0	3.0	38.0	58.0	0.702	2	1
2	Top management response is important to implement new innovation	1.0	0.0	3.0	41.0	54.0	0.696	4	
3	Top management is key to drive change for adopting new innovations	1.0	0.0	3.0	33.0	63.0	0.713	1	
	Technical Readiness								
4	Knowledge and experiences of IT human resources is crucial	0.0	0.0	2.0	59.0	39.0	0.674	5	2
5	Network connectivity, broadband, fiber optic connectors, and electrical power supply are crucial for cloud implementation	0.0	0.0	3.0	42.0	54.0	0.702	3	
6	Having a powerful infrastructures feature among the major criteria for cloud adoption	0.0	0.0	9.0	48.0	43.0	0.670	6	
	Size of Organization								
7	Smaller firms do not willingly accept newer technologies and adoption	7.0	29.0	28.0	30.0	5.0	0.398	30	10
8	Bigger firms more willing to adopt new innovations	0.0	1.0	8.0	63.0	28.0	0.637	15	

	due to higher resource allocation and capacity								
9	Cloud benefits both smaller and bigger firms due to its service flexibility	0.0	8.0	13.0	58.0	22.0	0.587	26	
	Data Security & Privacy								
10	Cloud-based application is safe to use if proper regulation is in place	0.0	1.0	8.0	63.0	28	0.563	29	8
11	Third party entity are the threat to cloud security and privacy	0.0	2.0	23.0	62.0	13.0	0.572	27	
12	Employee negligence are significant security threats	0.0	1.0	5.0	64.0	29.0	0.643	11	
	User Awareness								
13	Implicit awareness often lead to security risks	1.0	0.0	8.0	68.0	23.0	0.624	20	7
14	Keeping multiple stakeholders aware and involved is important	0.0	2.0	23.0	62.0	13.0	0.626	19	
15	Service providers should focus their advertisements on improving the awareness	1.0	0.0	9.0	73.0	17.0	0.611	23	
	Regulatory Environment								
16	Regulatory support is crucial for a successful cloud implementation	0.0	0.0	23.0	57.0	21.0	0.596	24	9
17	Absence of legal & regulatory system leads to difficulty in implement new innovation	0.0	2.0	23.0	62.0	13.0	0.567	29	
18	Government policies can exert	0.0	0.0	24.0	58.0	18.0	0.589	25	

	both positive and negative impact implementation								
	Compatibility								
19	Ability to adapt to current systems is crucial to successful implementation	0.0	0.0	9.0	63.0	28.0	0.639	14	5
20	Ability to adapt is important but not a priority	0.0	1.0	4.0	73.0	22.0	0.630	18	
21	Use of commonly used data models to design projects is significant in complex projects	0.0	0.0	10.0	71.0	28.0	0.620	21	
	Perceived Industry Pressure								
22	Competition increases the likelihood of innovation adoption	0.0	1.0	2.0	65.0	32.0	0.654	7	3
23	Significant advantage is acquired with successful implementation of new technology	0.0	0.0	3.0	73.0	24.0	0.641	13	
24	Advantage is acquired only of new system has proven benefits than conventional methods	0.0	0.0	1.0	71.0	28.0	0.654	8	
	Budget & Cost								
25	Organizations should have budget on new technology when they become available	0.0	1.0	11.0	66.0	22.0	0.617	22	6
26	Annual budget should always account for new innovations and technology	0.0	0.0	5.0	71.0	24.0	0.637	16	
27	Budget should be	0.0	0.0	5.0	72.0	23.0	0.635	17	

	allocated if new adoption is proven to be reliable								
	Project Complexity								
28	Adoption is viable if it helps with managing complex project	0.0	1.0	4.0	63.0	32.0	0.650	9	4
29	Complexity of project is where new innovation and technology should be applied	0.0	1.0	3.0	65.0	30.0	0.650	10	
30	The cloud solution helps to increase its focus on the clients	0.0	1.0	9.0	58.0	33.0	0.643	12	

4.3.3.1 Top Management Support

From the result of the generated output as shown in table 4.3 previously, the analysis ranks the critical success factor of Top Management Support according to the Relative Importance Index (RII); 1) Top management to drive change for adopting new innovations (RII = 0.713); 2) Top management awareness has a beneficial relationship to adopt an innovation (RII = 0.702); 3) Top management response is important to implement new innovation (RII = 0.696).

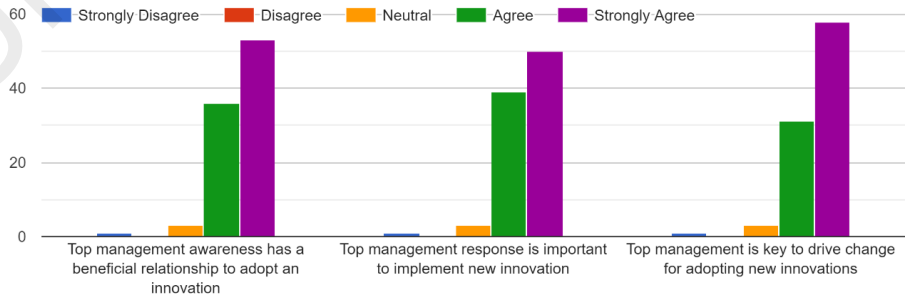

Figure 4.11: Top Management Support

4.3.3.2 Technical Readiness

From the result of the generated output as shown in table 4.3 previously, the analysis ranks the critical success factor of Technical Readiness according to the Relative Importance Index (RII); 1) Network connectivity, broadband, fibre optic connectors, and electrical power supply are crucial (RII = 0.702); 2) knowledge and experiences of IT human resources is crucial (RII = 0.674); 3) Having a powerful infrastructures feature among the major criteria for cloud adoption (RII = 0.670).

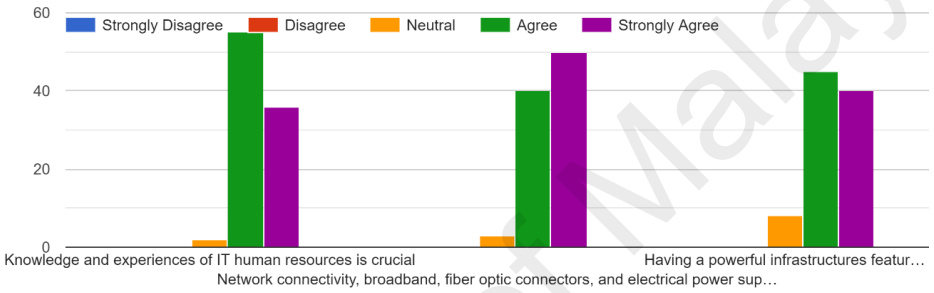

Figure 4.12: Technical Readiness

4.3.3.3 Size of Organization

From the result of the generated output as shown in table 4.3 previously, the analysis ranks the critical success factor of Size of Organization according to the Relative Importance Index (RII); 1) Bigger firms more willing to adopt new innovations due to higher resource allocation and capacity (RII = 0.637); 2) Cloud benefits both smaller and bigger firms due to its service flexibility (RII = 0.587); 3) Smaller firms do not willingly accept newer technologies and adoption (RII = 0.398).

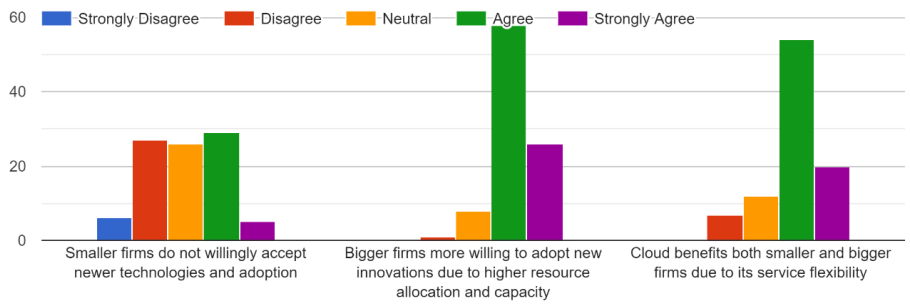

Figure 4.13: Size of Organization

4.3.3.4 Data Security & Privacy

From the result of the generated output as shown in table 4.3 previously, the analysis ranks the critical success factor of Data Security & Privacy according to the Relative Importance Index (RII); 1) Employee negligence are significant security threats (RII = 0.643); 2) Third party entity are the threat to cloud security and privacy (RII = 0.572); 3) Cloud based application is safe to use if proper regulation is in place (RII = 0.563).

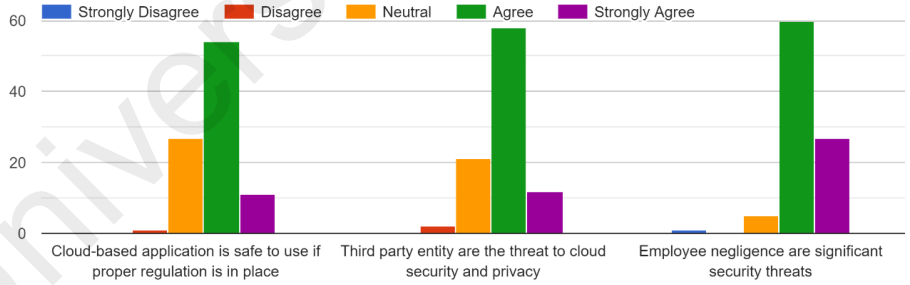

Figure 4.14: Data Security & Privacy

4.3.3.5 User Awareness

From the result of the generated output as shown in table 4.3 previously, the analysis ranks the critical success factor of User Awareness according to the Relative Importance

Index (RII); 1) Keeping multiple stakeholders aware and involved is important (RII = 0.626); 2) Implicit awareness often lead to security risks (RII = 0.624); 3) service providers should focus their advertisements on improving the awareness (RII = 0.611).

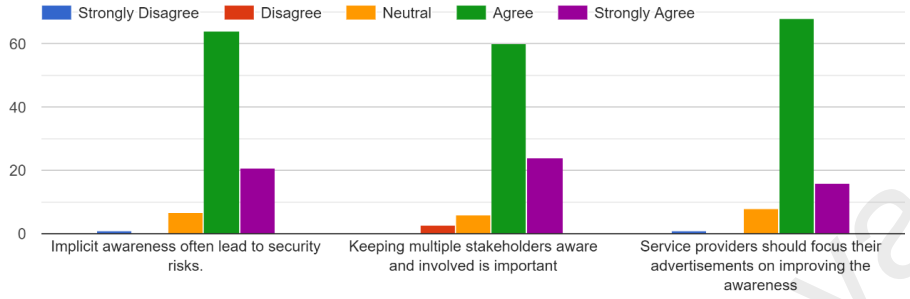

Figure 4.15: User Awareness

4.3.3.6 Regulatory Environment

From the result of the generated output as shown in table 4.3 previously, the analysis ranks the critical success factor of Regulatory Environment according to the Relative Importance Index (RII); 1) regulatory support is crucial for a successful cloud implementation (RII = 0.596); 2) Government policies can exert both positive and negative impact to implementation (RII = 0.589); 3) absence of legal & regulatory system leads to difficulty in implement new innovation (RII = 0.567).

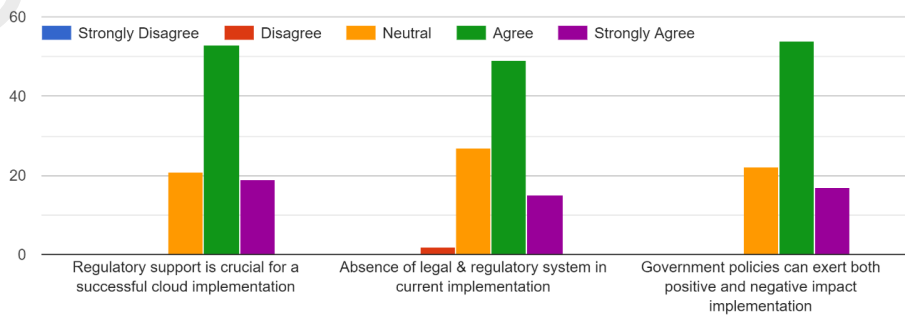

Figure 4.16: Regulatory Environment

4.3.3.7 Compatibility

From the result of the generated output as shown in table 4.3 previously, the analysis ranks the critical success factor of Compatibility according to the Relative Importance Index (RII); 1) Ability to adapt to current systems is crucial to successful implementation (RII = 0.639); 2) Ability to adapt is important but not a priority (RII = 0.630); 3) Commonly used data models to design projects is significant in complex projects (RII = 0.620).

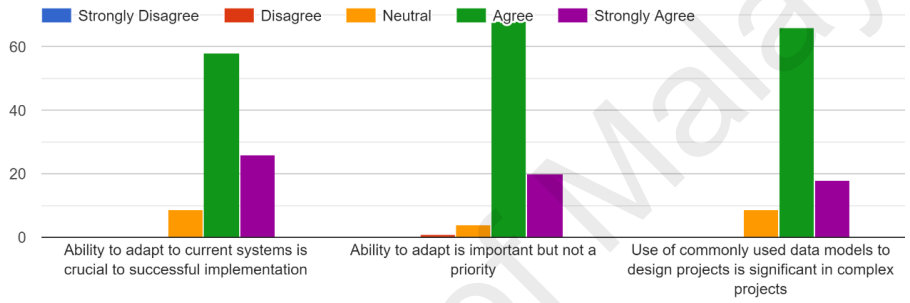

Figure 4.17: Compatibility

4.3.3.8 Perceived Industry Pressure

From the result of the generated output as shown in table 4.3 previously, the analysis ranks the critical success factor of Perceived Industry Pressure according to the Relative Importance Index (RII); 1) Competition increases the likelihood of innovation adoption (RII = 0.654); 2) Advantage is acquired only if new system has proven benefits than conventional methods (RII = 0.653); 3) Significant advantage is acquired with successful implementation of new technology (RII = 0.641).

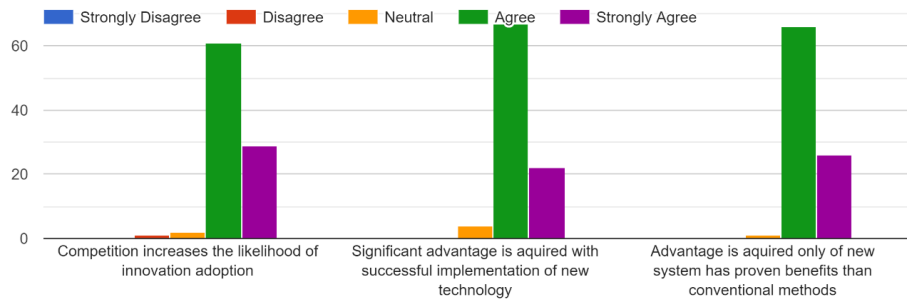

Figure 4.18: Perceived Industry Pressure

4.3.3.9 Budget & Cost

From the result of the generated output as shown in table 4.3 previously, the analysis ranks the critical success factor of Budget & Cost according to the Relative Importance Index (RII); 1) Annual budget should always account for new innovations and technology (RII = 0.637); 2) Budget should be allocated if new adoption is proven to be reliable (RII = 0.635); 3) Organizations should have budget on new technology when they become available (RII = 0.617).

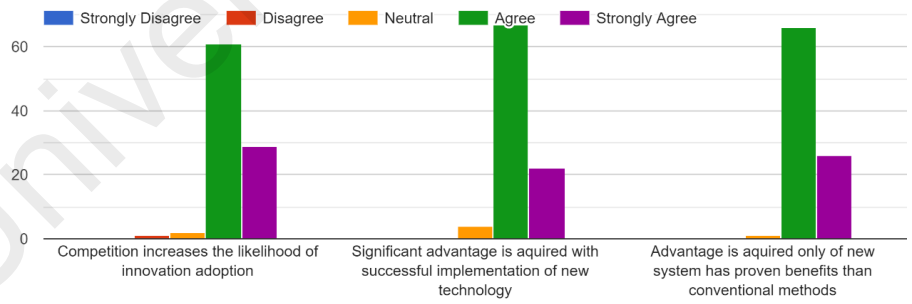

Figure 4.19: Budget & Cost

4.3.3.10 Project Complexity

From the result of the generated output as shown in table 4.3 previously, the analysis ranks the critical success factor of Project Complexity according to the Relative Importance Index (RII); 1) Adoption is viable if it helps with managing complex project (RII = 0.650); 2) Complexity of project is where new innovation and technology should be applied (RII = 0.650); 3) Cloud solution helps to increase its focus on the clients (RII = 0.643).

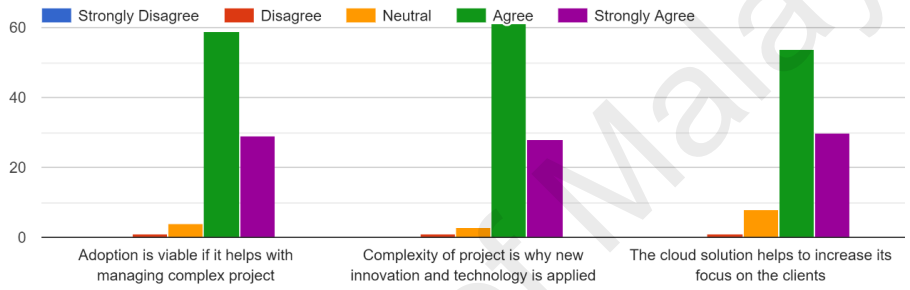

Figure 4.20: Project Complexity

4.3.4 Analysis on Impact of Cloud-Based Application/Services to Project Success

The dependent variable in this research is the project success. Project performance will be measured by an initial response from the respondents based on their perception about whether or not the project he or she has participated in and the implementation of cloud application or services has led to a project being successful or unsuccessful. The survey data that represents this are detailed in Table 4.4 below, which are the perception of the respondents on the impact of cloud based application or service to project success. The table also gives an overall overview of the industry on the number of years the respondents has utilizes cloud based application in order to assist them to manage project deliverables. 35.9% or 33 respondents have 5 to 10 years of experience in utilizing cloud

based application or services into their projects. This is followed by group of less than 5 years' experience with 29 respondents, or 31.5%. 10 to 15 years is represented by 17 respondents or 18.5% overall. 15 to 20 years of experience in utilizing cloud application is represented by 11 respondents or 12% and the group of more than 20 years of experience in utilizing cloud application is represented by 2 respondents, or 2.2%.

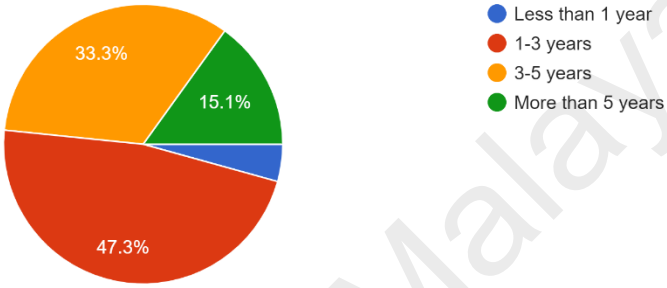

Figure 4.21: Working experience in using cloud-based applications and services

For the survey data on the perception of impact from cloud based application or services implementation to project success is also detailed in Table 4.4. The result of the generated output is from the five Likert scale from "5 = Strongly Agree, 4 = Agree, 3 = Neutral, 2 = Disagree to 1 = Strongly Disagree". 57% has indicated they do not believe that implementation of cloud based application will increase the chances of a project being delayed. 28% has a neutral view on the impact of cloud based application weather it could cause a project delay or not. However, 7% of total respondents believe that implementation of cloud based application could have an impact that could lead to a project being delayed.

On the perception if a cloud based application or service could contribute to in increased project time efficiency, a resounding 84% agrees. However, 8% remains neutral as they have yet to experience if cloud based application contributes to project time efficiency. In terms of cloud based applications contribution to overall project productivity and collaboration, a resounding 84% from overall respondents has indicated that cloud based applications contributes to an increase in project productivity as well as collaboration. On the perception if the implementation of cloud based application services has contributed to an increase in project success and project delivery, again, 84% is confident that its implementation has a positive impact to project success and project delivery.

Table 4.4: Industry Perception on impact of Cloud Technology Implementation

	Working experience in using cloud-based applications and services	Frequency	Percent %
	Less than 5 years	29	31.5
	5 – 10 years	33	35.9
	10 – 15 years	17	18.5
	15 – 20 years	11	12
	More than 20 years	2	2.2

	Perception of Project Performance	Percentage of respondents scoring				
		1	2	3	4	5
1	Cloud based application implementation contributes to increased Project Delay.	22.0	35.0	28.0	3.0	4.0
2	Cloud based application implementation contributes to increased project time efficiency.	0.0	0.0	8.0	60.0	24.0
3	Cloud based application implementation contributes to increased	0.0	0.0	8.0	54.0	30.0

	project productivity and collaboration.					
4	Cloud based application implementation contributes to increased Project Success and Project Delivery.	0.0	0.0	8.0	56.0	28.0

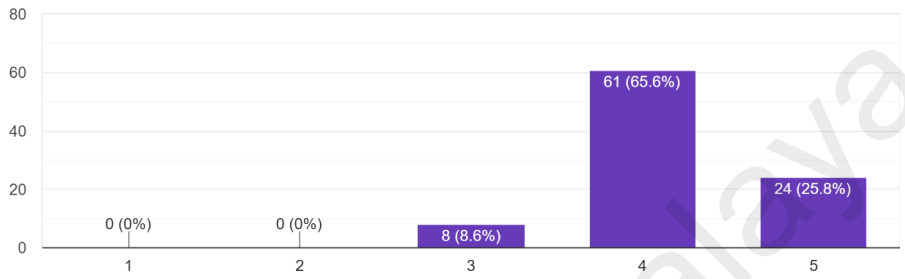

Figure 4.22: Cloud based application implementation contributes to increased Project Delay.

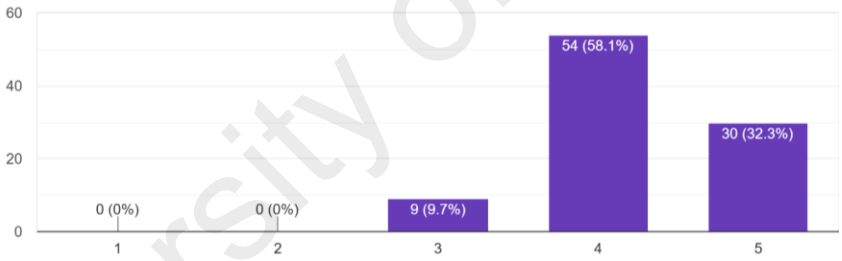

Figure 4.23: Cloud based application implementation contributes to increased project time efficiency.

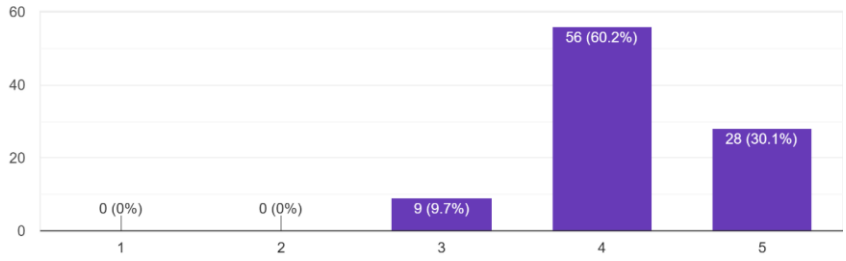

Figure 4.24: Cloud based application implementation contributes to increased project productivity and collaboration.

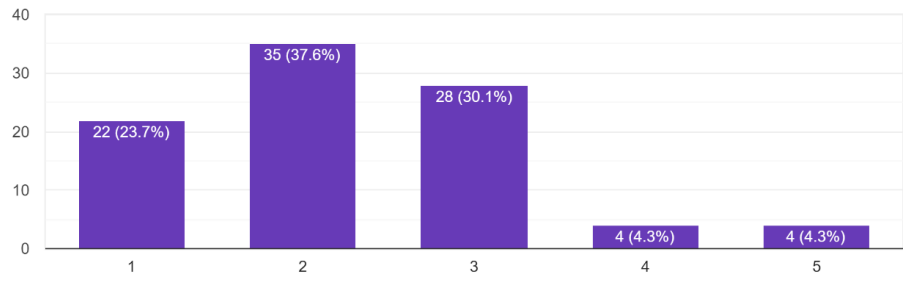

Figure 4.25: Cloud based application implementation contributes to increased Project Success and Project Delivery.

4.4 Summary

In summary, this chapter focusses on examining and analysing data obtained through quantitative research method of a questionnaire survey as part of the research. The quantitative method questionnaires were distributed to the representatives of 49 construction companies listed from the construction sector of the Main Board from Bursa Malaysia. It is believed that these companies possess the necessary market capital as well as other resources and has the capability to be competitive. The industry professionals from the listed companies also believed to have vast experience as well as being resourceful and innovative for them to handle complex project.

Through the quantitative method of questionnaire survey, the research results were presented and the researcher is able to get a general overview on the current utilization of cloud based application. The analysis ranks the most utilized cloud based application or services from the questionnaire survey as well as their experience. Analysis is then conducted on the critical success factors that is often involved in order to implement cloud based applications or services successfully. The same with previous analysis, the results are then being ranked according to its frequency and importance. The data on the perception of industry professionals for the impact of implementing cloud based application to project performance was also analysed.

CHAPTER 5: DISCUSSION

5.1 Introduction

This section discusses the results obtained in the earlier Chapter 4. First, information gathered in chapter 2 literature review identifies the research gap that needs to be covered in this research. This then leads to the process of data gathering through quantitative research method questionnaire survey. The results obtained by analysing the data shall be reviewed and discuss to study the current industry utilization of cloud based application or services. Further to this, the results obtained from the study of Critical Success Factors implemented for a successful implementation of cloud based application or services shall be reviewed and discussed. Finally, the data gathered weather cloud based application or services has any impact or relation to project success will be reviewed and discussed.

5.2 Discussion on Current Industry Utilization of Cloud Based Application or Services in Construction Management

While prior research suggested a positive relationship between the use of particular Information Technology (IT) tools and organizational performance, very few published studies have attempted to assess the influence of IT usage on project team-owner relationship and the performance of capital facility projects. This is the same in the case of utilization of cloud based application or services. Cloud computing is an emerging phenomenon and has been a major agenda in the field of computing over the last decade. The ability to facilitate speed, agility, flexibility, infinite elasticity, innovation as well as economic advantage, this emerging technology has the potential to increase the rate of responsiveness of organizations (Hamid et al, 2015).

5.2.1 Discussion Based on Overall Ranking of Cloud Application or Services Utilization

Results in Table 4.2 indicate the overall ranking of four (4) most used cloud-based application and services which are: (1) File Sharing/Storage (RII = 0.589); (2) Documentation Management (RII = 0.0.565); (3) Project Management (RII = 0.400); (4) Building Information Modelling (RII=0.300). The survey also indicated that 62% of respondents believed that cloud-based application/services is reliable.

i. File Sharing / Storage Application Services

Cloud file sharing or storage is a method for storing data in the cloud that provides servers and applications access to data through shared file systems. This compatibility makes cloud file storage ideal for workloads that rely on shared file systems and provides simple integration without code changes. It can also be defined as a service that provides simultaneous access for multiple users to a common set of file data in the cloud. Security for file sharing in the cloud is managed with user and group permissions enabling administrators to tightly control access to the shared file data.

In managing any type of projects, whether it be complex or not, many participants from different organizations have to carry out a vast number of different activities in construction management, working together simultaneously resulting in a huge amount of information and data that must be delivered and communicated throughout the project (Kornelius and Wamelink, 1998; Dawood et al., 2002; Pietroforte, 1997). As proven in the research result, cloud based file sharing and storage are becoming an increasingly popular service among construction professionals. Cheap storage space solutions provided by an influx of service

providers in, high amount internet traffic is expected to increase as expected, generated by cloud storage services. Cloud-based service has been introduced in recent years, with storage capacity, remote data centres and moving away from complex hardware management being offered to users and organizations.

ii. Documentation Management

From the result obtained in the research, documentation management is the second most utilized cloud based application or service. Document Management application has existed in the field since even before cloud computing, but only within the confines of the office building with dedicated servers. However, with the introduction of cloud computing, the combination of both has resulted in an increase in accessibility and performance of the document system. Private information and making them useful for daily task and ensuring it is properly handled has increased by the managing organizations, thus making them a crucial tool

iii. Cloud Based Project Management Application

There are many industry-leading tools for creating, managing and tracking project schedules and generating related reporting that could be used to make insightful decisions about projects. Having timely access to information on the performance of a construction project enables the design team and contractor to improve their decision- making so as to ensure project deliverables are met.

Within the construction industry in Malaysia, results obtained from the questionnaire survey has indicated that the usage of such applications or tool is still in its infancy. Construction professionals currently still practices conventional

method in managing project deliverables. In some cases, using conventional method does have its impact to decreasing project performance. More effort has to be put into awareness as well as exposure to introduce the application, hence leading to increased project success.

iv. Cloud Based Building Information Modelling (BIM)

From the result obtained in the research, it can be seen that BIM application in the Malaysian construction industry remains in its infancy. In Malaysia, the idea to implement BIM was introduced by the Director of Public Works Department (PW D) in 2007 (Jabatan Kerja Raya (JKR), 2013). The application of BIM to projects by construction players has been encourage by the government because BIM has a huge potential to facilitate solving problems of construction projects. As an example, BIM is able to prevent disputes between construction players, manage the right quantity for each structure, decrease construction cost and avoid project delay. The Malaysian Government has introduced several pilot projects as part of the government's initiative in exposing the construction industry to BIM. Nowadays, BIM implementation in Malaysia is been seen more suitable for complex projects and high-risk projects (Jabatan Kerja Raya (JKR), 2011) due to the high cost of adoption. However, construction players need to be aware of the benefits of BIM in helping them to improve implementation of construction processes.

5.3 Discussion on the Critical Success Factor for Implementation of Cloud Based Application or Services in Construction Management

Critical Success Factors (CSF) is the regions and activities which ought to be centred around basically so as to pick up the most fulfilling aftereffects of the cloud platform execution (Ziemba and Papaj, 2012, 2013). This research is sure that the analysis of critical success factors gives great reason for expressing what criteria ought to be pursued amid cloud platform adoption. In this section, the study shall compare the ranking derived based on overall and category ranking to discuss the critical success factor for implementation of cloud based application or services in construction management.

5.3.1 Discussion Based on Overall Ranking

Result in Table 4.3 indicate that the ten (10) most important critical success factor for implementation of cloud based application or services in construction management were: (1) Top management to drive change for adopting new innovations (RII = 0.713); (2) Top management awareness has a beneficial relationship to adopt an innovation (RII = 0.702); (3) Network connectivity, broadband, fiber optic connectors, and electrical power supply are crucial for cloud implementation (RII = 0.702); (4) Top management response is important to implement new innovation (RII = 0.696); (5) Knowledge and experiences of IT human resources is crucial (RII = 0.674); (6) Having a powerful infrastructures feature among the major criteria for cloud adoption (RII = 0.670); (7) Competition increases the likelihood of innovation adoption (RII = 0.654); (8) Advantage is acquired only of new system has proven benefits than conventional methods (RII = 0.654); (9) Adoption is viable if it helps with managing complex project (RII = 0.650) and (10) Employee negligence are significant security threats (RII = 0.643).

i. Top management to drive change for adopting new innovations.

Participation and involvement of top management, for example the CIO and CEO, cloud computing has been important to a degree with committing resources and managing IT. Zheng et al. (2013) found that the intention to adoption of the technology was led by the significant and positive influence of financial and IT human resource allocation by top management. The drive to change led by the top management is a crucial factor to adopt new innovations.

ii. Top management awareness has a beneficial relationship to adopt an innovation.

Top management awareness has been regarded as factor of moderate importance and necessity. However, an understanding of the current innovations in the industry in which a business operates and what it is that makes a business successful is essential, and would kick-start change management.

iii. Network connectivity, broadband, fibre optic connectors, and electrical power.

Utilizing cloud application and services requires constant and huge amount of access to the internet. More often than not, most organizations will look into their available network connectivity, fibre optics as well as all established hardware before deciding whether or not adopt new technology. Hence, technology readiness of higher degree leads to the organization being more prepared and considered an important factor for new innovations.

iv. Top management response is important to implement new innovation

More often than not, the availability of new innovations and technology is brought to the attention of the top management. The response of the top management after the introduction is normally makes or breaks decision, weather they see it as

something worth to be invested on. In ensuring education and training needs to utilize strategies and manage expectations for cloud implementation, having initial response from top management is important.

v. Knowledge and experiences of IT human resources

Strategic approach to the effective management of people in a company or organization such that they help their business gain a competitive advantage. IT human resource and infrastructure encompasses technology readiness. According to Wang et al. (2007), IT applications related to cloud computing implementation skills and knowledge are provided by the IT human resource.

vi. Having a powerful infrastructures feature

With the current growth of internet traffic, having powerful infrastructure is crucial to keep pace with its global growth. Infrastructure supports and enables change, rather than being an obstacle or a constraint. The ability to effortlessly build and rebuild any part of the infrastructure is powerful. It removes much of the risk, and fear, when making changes. Failures can be handled quickly and with confidence. New services and environments can be provisioned with little effort.

vii. Competition increases the likelihood of innovation adoption

The probability of implementing new technology is increased in a competitive environment (Thong, 1999), because the rate and need of implementing new technology will be increased by an uncertain market situation. Typically, competitive pressure is what is described when implementing new innovation is affected by elements of the market environment (Iacovou et al. 1995), which was

identified as an element of criticalness when smaller organizations intends to implement new innovations.

viii. Advantage is acquired only of new system has proven benefits than conventional methods

More often than not, most organization would only adopt new technology or innovation if they foresee that it provides an advantage or benefits. This is understandable considering that certain organization works on a predetermined budget. Cutting-edge technology can create high benefits for businesses that are willing to be early adopters. This strategy, however, requires businesses to abandon technologies that never fully mature or that are themselves dropped by their parent companies. Hence, most organization would normally proceed with adoption if they are proven to provide the necessary advantage than normal conventional processes.

ix. Adoption is viable if it helps with managing complex project

Benefits of utilizing cloud technology could not be gained by all projects, mainly, minor project with minimal financial resource. They are affected by several factors such as not available infrastructure and lack of trained staff (Sloniec, 2015). However, if adoption provides viable benefits to reduce construction cost and avoid design problems as well as any other, then it cloud provide a platform for complex project to be managed efficiently.

x. Employee negligence are significant security threats

Lack of training provided to employees, the work-from-home trend and the rise in customer concern with the security of their own data is of crucial factor to be

tackled if an organization is migrating to new technology. Two of the main reasons why companies are failing to detect and prevent employee negligence is due to a) a lack of budget, and b) a lack of suitable monitoring technology. It's not enough to say that you can't afford a solution, or that nothing suits your environment. There is also no excuse for not having regular training sessions for your staff to educate them how to avoid cyber-security threats

5.3.2 Discussion Based on Category Ranking

5.3.2.1 Top Management Support

From the result of the generated output as shown in table 4.3 above, it can be vividly seen that the Relative Importance Index (RII) for the Top Management Support critical success factor with 0.713, the highest factor contributing is that top management is key to drive change for adopting new innovations as intention to adoption of the technology was led by the significant and positive influence of financial and IT human resource allocation by top management.. The drive to change led by the top management is a crucial factor to adopt new innovations. The second factor contributing to the Top Management Support is top management awareness has a beneficial relationship to adopt an innovation with RII of 0.702. The impact of having awareness only is not as significant as providing the drive itself, while the third factor with an RII of 0.696 is top management response is important to implement new innovation.

5.3.2.2 Technical Readiness

From the result of the generated output as shown in table 4.3 above, it can be vividly seen that the Relative Importance Index (RII) for the Technical Readiness critical success factor with 0.702, the highest factor contributing is that network connectivity, broadband, fibre optic connectors, and electrical power supply are crucial for cloud implementation. As mentioned earlier in literature, the cloud based applications is internet centred and will be handling large amount of traffic. Hence having the suitable network setup will smoothen the transition process. The second factor contributing to the Technical Readiness is knowledge and experiences of IT human resources is crucial with RII of 0.674, while the third factor with an RII of 0.670 is having a powerful infrastructures feature among the major criteria for cloud adoption.

5.3.2.3 Size of Organization

From the result of the generated output as shown in table 4.3 above, it can be vividly seen that the Relative Importance Index (RII) for the Size of Organization critical success factor with 0.637, the highest factor contributing is that bigger firms more willing to adopt new innovations due to higher resource allocation and capacity. This is because due to their market capital and capacity to undertake complex projects, as well as having necessary resources to adopt new innovation to gain market advantage over competitors. The second factor contributing to the Size of Organization is cloud benefits both smaller and bigger firms due to its service flexibility with RII of 0.587, while the third factor with an RII of 0.398 is smaller firms do not willingly accept newer technologies and adoption.

5.3.2.4 Data Security & Privacy

From the result of the generated output as shown in table 4.3 above, it can be vividly seen that the Relative Importance Index (RII) for the Data Security & Privacy critical success factor with 0.643, the highest factor contributing is that employee negligence are significant security threats. Lack of training provided to employees, is of crucial factor to be tackled if an organization is migrating to new technology. The second factor contributing to the Data Security & Privacy is third party entity are the threat to cloud security and privacy with RII of 0.572, while the third factor with an RII of 0.563 is cloud based application is safe to use if proper regulation is in place.

5.3.2.5 User Awareness

From the result of the generated output as shown in table 4.3 above, it can be vividly seen that the Relative Importance Index (RII) for the User Awareness critical success factor with 0.626, the highest factor contributing is that keeping multiple stakeholders aware and involved is important. Providing awareness helps to increase the usage and utilization and is a positive impact to cloud adoption. It also provides assurance to users on the security of the system, hence, providing awareness to a wider group of stakeholders is crucial for implementation. The second factor contributing to the User Awareness is Implicit awareness often lead to security risks with RII of 0.624, while the third factor with an RII of 0.611 is service providers should focus their advertisements on improving the awareness.

5.3.2.6 Regulatory Environment

From the result of the generated output as shown in table 4.3 above, it can be vividly seen that the Relative Importance Index (RII) for the Regulatory Environment critical success factor with 0.596, the highest factor contributing is that regulatory support is crucial for a successful cloud implementation. The second factor contributing to the Regulatory Environment is Government policies can exert both positive and negative impact to implementation with RII of 0.589, while the third factor with an RII of 0.567 is absence of legal & regulatory system leads to difficulty in implement new innovation.

5.3.2.7 Compatibility

From the result of the generated output as shown in table 4.3 above, it can be vividly seen that the Relative Importance Index (RII) for the Compatibility critical success factor with 0.639, the highest factor contributing is that ability to adapt to current systems is crucial to successful implementation. The second factor contributing to the Compatibility is ability to adapt is important but not a priority with RII of 0.630, while the third factor with an RII of 0.620 is use of commonly used data models to design projects is significant in complex projects.

5.3.2.8 Perceived Industry Pressure

From the result of the generated output as shown in table 4.3 above, it can be vividly seen that the Relative Importance Index (RII) for the Perceived Industry Pressure critical success factor with 0.654, the highest factor contributing is that competition increases the likelihood of innovation adoption. The second factor contributing to the Perceived

Industry Pressure is advantage is acquired only if new system has proven benefits than conventional methods with RII of 0.653, while the third factor with an RII of 0.641 is significant advantage is acquired with successful implementation of new technology.

5.3.2.9 Budget & Cost

From the result of the generated output as shown in table 4.3 above, it can be vividly seen that the Relative Importance Index (RII) for the Budget & Cost critical success factor with 0.637, the highest factor contributing is that annual budget should always account for new innovations and technology. Having consistent budget to keep up with current innovation is always an important aspect, allowing adoption to be carried out seamlessly. This allows for some risk to be taken as not all innovations has a positive impact. Hence, the second factor contributing to the Budget & Cost is budget should be allocated if new adoption is proven to be reliable with RII of 0.635, while the third factor with an RII of 0.617 is organizations should have budget on new technology when they become available.

5.3.2.10 Project Complexity

From the result of the generated output as shown in table 4.3 above, it can be vividly seen that the Relative Importance Index (RII) for the Project Complexity critical success factor with 0.650, the highest factor contributing is that adoption is viable if it helps with managing complex project. This can be seen as a common trend, where most organizations only make the decision to adopt the latest innovation if it is proven to have positive impact on more complex projects. The second factor contributing to the Project

Complexity is complexity of project is where new innovation and technology should be applied with RII of 0.650 where the adoption is not on the whole of the project, but more of a targeted management area. The third factor with an RII of 0.643 is the cloud solution helps to increase its focus on the clients.

5.4 Impact of Cloud-Based Application/Services to Project Success

The dependent variable in this research is the project success. Project performance will be measured by an initial response from the respondents about whether or not the project he or she has participated in and the implementation of cloud application or services has led to a project being successful or unsuccessful. The survey data that represents the perception of the respondents on the impact of cloud based application or service to project success.

From the data obtained, 57% has indicated they do not believe that implementation of cloud based application will increase the chances of a project being delayed. Many have suggested that implementation of any technology has not been the factor that a project is delayed. This is in line with other research conducted, citing that most causes of delay are often related to weather, financing, labour related, or improper planning. However, implementation of new technology does not always go smoothly. Latiffi et al. (2013) has indicated that proper planning and execution is important to ensure a successful implementation, without it having any impact to the overall project time. Initial study should be conducted to identify suitable entry point of implementation. Awareness among stakeholders and employees is also important, as this ensures that the entire organization is ready to handle the adoption process. It is also advisable if implementation can be done

in stages to smoothen the process. This will allow the implementation process to be managed efficiently in order to handle any potential problems that may be encountered.

28% has a neutral view on the impact of cloud based application weather it could cause a project delay or not, this could be due to lack of experience or involvement in closing of project. Most construction projects go on for several years, and naturally some employees may not stay until project completion. It is likely that they have not experience if any cloud implementation is proven to not have any impact or causing any delays to a project. However, 7% of total respondents believe that implementation of cloud based application could have an impact that could lead to a project being delayed. Further details on this is unable to be retrieved as the respondent does not provide any causes.

On the perception if a cloud based application or service could contribute to in increased project time efficiency, a resounding 84% agrees. However, 8% remains neutral as they have yet to experience if cloud based application contributes to project time efficiency. The design and implementation of a real-time object-oriented bi-directional system, allowed information (e.g., the status of the 'As-Built' schedule) to be captured on-site and synchronized with a federated cloud-based application.

In terms of cloud based applications contribution to overall project productivity and collaboration, a resounding 84% from overall respondents has indicated that cloud based applications contributes to an increase in project productivity as well as collaboration. Cloud-based application software's or platforms can be used to achieve these demands as it could be applied in various respects to the construction industry, including but not limited to analysis of structure, design architecture, procurement management, estimating of cost, and planning and control of a project. On the perception if the implementation of

cloud based application services has contributed to an increase in project success and project delivery, again, 84% is confident that its implementation has a positive impact to project success and project delivery. Implementing cloud based application in the construction industry can increase the overall quality of projects and improve image of the industry. Several cloud based applications such as project management and BIM have been used in Malaysian construction industry for improving construction processes. Cloud based applications such as BIM benefits construction projects by improving project schedule, detecting any clash during the design stage, decreasing construction cost and improving communication between construction players. Implementing this innovation in construction projects can lead to successful construction of projects.

5.5 Conclusion

This chapter discussed the research result extensively. The association of the findings with previous work done by others was presented. The discussion was mainly providing further elaboration of the most significant application of critical success factors to implement a cloud based application in construction projects in Malaysia discovered in the study. In the next chapter, Chapter Six (6), shall summarize the whole research report and propose recommendation for future works.

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

This chapter of the study forms the concluding part of this academic research work. In this chapter, a summary of all the discussions held in the analytical sections of the study is presented with conclusions drawn accordingly. Areas that could be explored in further outlook on the subject matter are also presented in this concluding chapter of the research.

6.2 Chapters Summary

The implementation of cloud based application in construction management in Malaysia is discussed in a field research. It studied the current level of development of the applications in the current industry environment to gain on overall overview of its acceptance and perception on it. A qualitative method of questionnaire survey was then conducted to gain further information regarding the overall perception of cloud based applications and the implementation of critical success factors.

6.3 Key Findings

From literature review, four (4) types of cloud based application utilized in construction and project management. Study was conducted to gain an overview of current industry utilization and ranked the application according to most utilized: 1) Document Management; 2) File Sharing/Storage; 3) Project Management tools; and 4) Building Information Modelling (BIM).

The frequency and importance of the critical success factors was also studied. Critical

Success Factors (CSF) is the regions and activities which ought to be centred around basically so as to pick up the most fulfilling aftereffects of the cloud platform execution (Ziemba and Papaj, 2012, 2013). Thirty (30) critical success factor were identified through the research and combined into ten (10) categories. The categories are:

i. Top Management Support
ii. Technical Readiness
iii. Size of Organization
iv. Data Security & Privacy
v. User Awareness
vi. Regulatory Environment
vii. Compatibility
viii. Perceived Industry Pressure
ix. Budget & Cost
x. Project Complexity

The importance index of each critical success factor is calculated. Data collected were analysed by frequency and importance.

The dependent variable in this research is the project success. Project performance will be measured by an initial response from the respondents about whether or not the project he or she has participated in and the implementation of cloud application or services has led to a project being successful or unsuccessful. Data obtained from the research indicated that the respondents perceived that cloud based applications and services contributes to Project Success and Improves Project Delivery.

6.4 Revisiting Research Objectives

Before the research was conducted, several research objectives were identified by the researcher in order to assist in achieving the overall research aim which is to analyse the success factors for cloud based platform implementation and their impact to project performance in construction management in Malaysia. Below are the conclusions on the achievement of the research objectives:

i. To identify common cloud-based tools among construction professionals to manage increasing project complexity.

During literature review, the research identified the types of applications or services available. From the quantitative method of questionnaire survey, data was gathered from construction professionals on the rate of application utilization. The researcher was able to understand the most common and current trend of the construction industry on the overall overview and development of cloud based application.

ii. To identify factors that lead to successful performance of cloud-based applications.

From literature review, the research identified several factors that leads to successful performance of cloud based applications. The factors were then analysed to determine which are of most critical and can be applied by current construction organizations.

iii. To determine the critical success factors (CSF) to implement a cloud-based platform and their impact to project success in construction management.

Data was gathered from questionnaire survey on the frequency and importance of the CFS implementation. From the analysis, the research was able to rank the CFS and the perception on the impact of cloud based application in order to understand factors that can lead to project success.

6.5 Limitation of the Research

Several limitations were identified before and during the preparing of the research. The limitation can be divided into two categories; 1) Environmental Impact; 2) Technical Impact. For the environmental impact, the current viral outbreak of COVID-19, has left most of Malaysia in lockdown for several months. With work on non-essential activities not allowed, most of the respondents was not in office and with being at another place rather than the workplace, could have an impact to their responses to the survey questionnaire. The method of questionnaire distribution was also impacted by this, as no appointment can be made and responses are solely based on the respondent's own initiative to return their responses. Interview method also has to be discarded as it could lead to complications and difficulty to obtain response. On the technical impact, several was identified in the research. The companies chosen to be surveyed are those listed in the main board for construction in Bursa Malaysia. These companies are selected due to their market capital and capacity to undertake complex projects, as well as having necessary resources to adopt new innovation. Further to this, it was stated by Latiffi et al. (2013), that due to the cost of implementation, the utilization of cloud based applications such as BIM and project management software's has been limited to complex and high risk projects only. Hence, this limits the available information regarding its implementation.

6.6 Suggestion for Improvement

Numerous researches conducted has proven that cloud application such as BIM and project management application provides many advantages. However, from the literature review, the researcher found that, in the Malaysia information technology environment, Malaysia still lacked the necessary regulatory and legal guidelines and support for cloud technology. The absence of this could hinder the development of cloud technology and can obstruct it utilization. With the establishment of regulatory and legal support, it will provide much needed confidence and assurance to implement or adopt cloud technology in their organization and can lead to it being used more widely in construction projects in Malaysia.

From the quantitative research of questionnaire survey, the researcher found that it clearly shows there is an extensive utilization of cloud based application in construction management in Malaysia in the forms of document management and file sharing/storage applications. However, the utilization of project management and building information modelling (BIM) in Malaysia is still in its infancy. Several researches also suggested that the usage of these applications is seen more suitable to complex and high risk projects due to the overall investment required for implementation. As a suggestion to increase utilization, the government can play a role as clients of many complex and high risk projects, and encourages construction players to apply cloud based project management and BIM to projects because of their huge potential to facilitate solving problems of construction projects.

6.7 Recommendations

This research has the potential to assist construction players or governments in assessing the readiness of their staff toward cloud based applications before the deployment. Implementation of cloud computing in Malaysia and other developing countries is growing and even intensified in recent years. Establishment of guidelines or framework for implementation and legal regulatory support is still ongoing and should be prioritised in Malaysia. Future work can be done to evaluate the preparedness of Malaysia's construction organizations to adapt, whereby both qualitative and quantitative study can be applied. The qualitative part will include interviews with several experts in this field, including CIO from public sector agencies. While the quantitative part will involve data collection work through a survey among public sector agencies. The outcome could lead to a framework for implementation guidelines to be established.

REFERENCES

Abdollahzadegan, A., Hussin, C., Razak, A., Moshfegh Gohary, M., & Amini, M. (2013). The organizational critical success factors for adopting cloud computing in SMEs. *Journal of Information Systems Research and Innovation (JISRI), 4*(1), 67-74.

Ahmad Latiffi, Aryani & Mohd, Suzila & Kasim, Narimah & Fathi, Mohamad Syazli. (2013). Building Information Modeling (BIM) Application in Malaysian Construction Industry. International Journal of Construction Engineering and Management. 2. 6. 10.5923/s.ijcem.201309.01..

Akinsiku, O. E., & Akinsulire, A. (2012). StakeholdersPerception of the Causes and Effects of Construction Delays on Project Delivery. *Journal of Construction Engineering and Project Management*, *2*(4), 25-31.

Alvesson, M. (2003). Beyond Neopositivists, Romantics, and Localists: A Reflexive Approach to Interviews in Organizational Research. Academy of Management Review. 28. 10.2307/30040687.

Armbrust, M., Armando F., et al. (2009). "Above the Clouds: A Berkeley View of Cloud Computing." Technical Report No. UCB/EECS-2009-28, Electrical Engineering and Computer Sciences, University of California at Berkeley. Retrieved from http://www.eecs.berkeley.edu/Pubs/Tec hRpts/2009/EECS-2009-28.pdf, on August 31, 2009.

Alaskari, O. A. M. M., Ahmad, M. M., Dhafr, N., & Pinedo-Cuenca, R. (2013). Critical successful factors (CSFs) for successful implementation of lean tools and ERP systems.

Alvesson, M. (2003). Methodology for close up studies–struggling with closeness and closure. *Higher education*, *46*(2), 167-193.

Anumba, C. J., & Ruikar, K. (2002). Electronic commerce in construction—trends and prospects. *Automation in construction*, *11*(3), 265-275.

Ashok, A. (2017). 8 Trends in Cloud Computing for 2018. Retrieved from https://medium.com/@Unfoldlabs/8-trends-in-cloud-computing-for-2018-d893be2d8989

Barara, I. (2014). *Cloud Computing Security Concerns and Challenges.* Retrieved from https://technologyevaneglist.wordpress.com/2014/03/25/cloud-computing-security-concerns-and-challenges/

Beach, T. H., Rana, O. F., Rezgui, Y., Parashar, M. (2013), "Cloud Computing for the Architecture Engineering & Construction Sector: Requirements Prototype & Experience", *Journal of Cloud Computing: Advances Systems and Applications*, vol. 2, no. 1, pp. 8.

Berbner, R., Grollius, T., Repp, N., Heckmann, O., Ortner, E., & Steinmetz, R. (2005). An approach for the Management of Service-oriented Architecture (SoA) based Application Systems. In *EMISA* (pp. 208-221).

Bisong, A., & Rahman, M. (2011). An overview of the security concerns in enterprise cloud computing. *arXiv preprint arXiv:1101.5613*.

Blee, K. M., & Taylor, V. (2002). Semi-structured interviewing in social movement research. *Methods of social movement research*, *16*, 92-117.

Bryman, A., & Bell, E. (2007). Business research strategies. *Business research methods*.

De Chaves, S. A., Uriarte, R. B., & Westphall, C. B. (2011). Toward an architecture for monitoring private clouds. *IEEE Communications Magazine*, *49*(12), 130-137.

Blee, K.M. & Taylor, Verta. (2002). Semi-Structured Interviewing in Social Movement Research. Methods Of Social Movement Research. 92-117.

Bulmer, Simon. (1997) *"New institutionalism, the single market and EU governance"*., WA.

Buyya, R., Chee, S. Y., and Venugopal, S. (2008). Market-oriented cloud computing: Vision, hype, and reality for delivering it services as computing utilities. CoRR, (abs/0808.3558).

Braun, Virginia & Clarke, Victoria. (2006). Using Thematic Analysis in Psychology. Qualitative research in psychology. 3. 77-101. 10.1191/1478088706qp063oa.

Cavana, R. Y., Delahaye, B. L., & Sekaran, U. (2001). *Applied business research: Qualitative and quantitative methods*. John Wiley & Sons Inc.

Channabasavaiah, K., Holley K., and Tuggle, E. M. (2003). Migrating to Service-oriented architecture – part 1, http://www-106.ibm.com/developerworks/webservices/library/ws-migratesoa/, IBM developerWorks.

Chan, A. P., Scott, D., & Chan, A. P. (2004). Factors affecting the success of a construction project. *Journal of construction engineering and management*, *130*(1), 153-155.

Cohen, L., Manion, L., & Morrison, K. (2007). Research Methods in Education (6th ed.). Abingdon: Routledge.

Creswell, John. (1997). Qualitative inquiry and research design: Choosing among five traditions. Networks: An Online Journal for Teacher Research. 1. 62-62. 10.4148/2470-6353.1252.

Creswell, J. W. (2008). Educational research: Planning, conducting, and evaluating quantitative and qualitative research (3rd ed.). Upper Saddle River, NJ: Pearson Education, Inc.

Creswell, J. W. (2008). Qualitative, quantitative, and mixed methods approaches.

Dawood, N., Akinsola, A., & Hobbs, B. (2002). Development of automated communication of system for managing site information using internet technology. *Automation in construction*, *11*(5), 557-572.

Denzin, N. K., & Lincoln, Y. S. (2000). Methods of collecting and analyzing empirical materials. *Handbook of qualitative research*, *2*, 710-813.

Dubey, A. & Wagle, D. (2007). Delivering software as a service. The McKinsey Quarterly. May.

Edmondson, A. & McManus, S. (2007). Methodological Fit in Management Field Research. Academy of Management Review. 32. 1155-1179. 10.5465/AMR.2007.26586086.

Egbu, C., Botterill, K., & Bates, M. (2001, September). The influence of knowledge management and intellectual capital on organizational innovations. In *Proceedings of the 17th Annual Conference of the Association of Researchers in Construction Management (ARCOM)* (pp. 186-196).

Eisenhardt M., Kathleen. (1989). Building Theory From Case Study Research. The Academy of Management Review. 14. 532-550. 10.2307/258557.

Edmondson, A. C., & McManus, S. E. (2007). Methodological fit in management field research. *Academy of management review*, *32*(4), 1246-1264.

Forsman, M., Glad, A., Lundberg, L., & Ilie, D. (2015). Algorithms for automated live migration of virtual machines. *Journal of Systems and Software*, *101*, 110-126.

Fraenkel, J. R., & Wallen, N. E. (2003). Observation and interviewing. *How to design and evaluate research in education*, *5*, 455-463.

Fraenkel, J. R. & Wallen, N. E. (2003). How to design and evaluate research in education. Fifth ed. New York: McGraw-Hill.

Froese, T., Yu, K., Liston, K., & Fischer, M. (2000). System architectures for AEC interoperability. *Proceedings of Construction Information Technology*, *1*, 362-373.

Gersick, C. (1991). Revolutionary Change Theories: A Multilevel Exploration of the Punctuated Equilibrium Paradigm. Academy of Management Review. 16. 10.5465/AMR.1991.4278988.

Golden-Biddle, Karen & Locke, Karen. (1993). Appealing Work: An Investigation of How Ethnographic Texts Convince. Organization Science - ORGAN SCI. 4. 595-616. 10.1287/orsc.4.4.595.

Gersick, C. J. (1991). Revolutionary change theories: A multilevel exploration of the punctuated equilibrium paradigm. *Academy of management review*, *16*(1), 10-36.

Gill, J. and Johnson, P. (1997) Research methods for managers, Paul Chapman Publishing Ltd, London.

Gliner, J. A., Morgan, G.A., and Leech N. L. (2009). *Research methods in applied settings: An integrated approach to design and analysis*. 2d ed. New York: Routledge.

Grabski, S. V., & Leech, S. A. (2007). Complementary controls and ERP implementation success. *International Journal of Accounting Information Systems*, *8*(1), 17-39.

Golden-Biddle, K., & Locke, K. (1993). Appealing work: An investigation of how ethnographic texts convince. *Organization science*, *4*(4), 595-616.

Hamid, H. & Mohd Yusof, M., (2015). State-of-the-art of cloud computing adoption in malaysia: A review. Jurnal Teknologi. 77. 10.11113/jt.v77.6499.

Hand, E. (2007). "Head in the clouds," *Nature*, volume 449, number 7165 (25 October), p. 963.

Hashizume, K., Fernandez, E. B., & Larrondo-Petrie, M. M. (2012, December). A pattern for Software-as-a-Service in Clouds. In *2012 ASE/IEEE International Conference on BioMedical Computing (BioMedCom)* (pp. 140-144). IEEE.

Iyer, Bala & Henderson, John. (2010). Preparing for the Future: Understanding the Seven Capabilities of Cloud Computing.. MIS Quarterly Executive. 9.

Jabatan Kerja Raya (JKR) (2013). Pengenalan BIM. Retrieved April 23, 2013, fromhttp://www.jkr.gov.my/prokom/index.php?option=com_content&view=article&id=310&Itemid=476&lang=ms

Jabatan Kerja Raya (JKR) (2011). Laporan Tahunan JKR 2011, pp 28-29. Retrieved March 12, 2013, from http://www.jkr.gov.my/var/files/File/dokumen/laporan_tahunan_jkr_2011.pdf

Jaeger, P.T., Lin, J. and Grimes, J. (2008). "Cloud computing and information policy: Computing in a policy cloud?" *Journal of Information Technology & Politics*, volume 5, number 3, at http://www.jitp.net/m_archive.php?p=7.

Kumar, R. (1999) Research Methodology: A Step-by-Step Guide for Beginners. Sage Publications, London, Thousand Oaks, New Delhi.

Kalleberg, A. (2000). Nonstandard Employment Relations: Part-Time, Temporary and Contract Work. Annu. Rev. Sociol. 16. 341-65. 10.1146/annurev.soc.26.1.341.

Kvale, S. E. (1989). *Issues of validity in qualitative research*. Studentlitterature.

Kidder, L. 1981. Research Methods in Social Relations (4th ed.). New York: Holt, Rinehart and Winston.

Kim, W. (2009). Cloud computing: Today and tomorrow. *Journal of object technology*, *8*(1), 65-72.

Kornelius, L. & Wamelink, H. (1998). The virtual corporation: Learning from construction. Supply Chain Management-an International Journal - SUPPLY CHAIN MANAGEMENT. 3. 193-202. 10.1108/13598549810244278.

Kothari C.R., (2010), Research Methodology: Methods and Technique, New Delhi: New Age International Publishers, p. 31

Kerlinger, F.N. (1986). Foundations of Behavioral Research, 3rd edn, Holt Rinehart & Winston.

Kerlinger, F. N., & Lee, H. B. (2000). Foundations of behavioral research (4th ed.). Holt, NY: Harcourt College Publishers.

Kidder, L. H. (1981). Qualitative research and quasi-experimental frameworks. *Scientific inquiry and the social sciences*, 226-256.

Kalleberg, A. L., Marsden, P. V., Aldrich, H. E., & Cassell, J. W. (1990). Comparing organizational sampling frames. *Administrative Science Quarterly*, 658-688.

Kumar, V. (2002). *Introduction to parallel computing*. Addison-Wesley Longman Publishing Co., Inc..

Kumar, B., Cheng, J. C., & McGibbney, L. (2010, June). Cloud computing and its implications for construction IT. In *Computing in Civil and Building Engineering, Proceedings of the International Conference* (Vol. 30, p. 315).

Li, H., Love, P. E., & Gunasekaran, A. (1999). A conceptual approach to modeling the procurement process of construction using petri-nets. *Journal of Intelligent Manufacturing*, *10*(3-4), 347-353.

Leidecker, J. K., & Bruno, A. V. (1984). Identifying and using critical success factors. *Long range planning*, *17*(1), 23-32.

Langley, A. (1999). Strategies For Theorizing From Process Data. Academy of Management Review. 24. 691-710. 10.2307/259349.

Markus, M. L., & Tanis, C. (2000). The enterprise systems experience-from adoption to success. *Framing the domains of IT research: Glimpsing the future through the past*, *173*(2000), 207-173.

Meadows, L. M., & Morse, J. M. (2001). Constructing evidence within the qualitative project. *The nature of qualitative evidence*, 187-200.

Meadows, Lynn & Morse, J.M.. (2001). Within-project validation. Constructing evidence within the qualitative project. 187-200.

Marston, S., Li, Z., Bandyopadhyay, S., Zhang, J., & Ghalsasi, A. (2011). Cloud computing — The business perspective. Decision Support Systems, 51(1), 176–189. doi:10.1016/j.dss.2010.12.006

Matthews, K. (2018). *How The Cloud Has Changed The Construction Industry*. Retrieved from https://cloudtweaks.com/2018/07/cloud-construction-industry/

Meadows, L. & Morse, J. M. (2001). Constructing evidence within the qualitative project. In J. M. Morse, J. Swanson & A. Kuzel, (Eds.). The nature of evidence in qualitative inquiry. (pp. 187 — 202),Thousand oaks, CA: Sage

Miller, R., & Lessard, D. (2001). Understanding and managing risks in large engineering projects. International Journal of Project Management, 19(8), 437–443.

Miller, R., & Lessard, D. R. (2001). *The strategic management of large engineering projects: Shaping institutions, risks, and governance*. MIT press.

Minato, T. (2003). Design documents quality in the Japanese construction industry: factors influencing and impacts on construction process. *International Journal of Project Management*, *21*(7), 537-546.

McGrath, J. E. (1981). Dilemmatics: The study of research choices and dilemmas. *American Behavioral Scientist*, *25*(2), 179-210.

Myers, M. (1997). Qualitative Research in Information Systems. MIS Quarterly. 21. 10.2307/249422.

Norshakila, R. Fathi, M. S. & Abedi, M. (2013). A Review of Project and Programme Management Reference Models for the Construction Industry. International Journal of Construction Engineering and Management. 2. 4. 10.5923/s.ijcem.201309.04..

Ofori, G. (2015). Nature of the construction industry, its needs and its development: A review of four decades of research. *Journal of construction in developing countries*, *20*(2), 115.

Pinfield, L. (1986). A Field Evaluation of Perspectives on Organizational Decision Making. Administrative Science Quarterly. 31. 365. 10.2307/2392828.

Pentland, B. (1999). Building Process Theory with Narrative: From Description to Explanation. The Academy of Management Review. 24. 711. 10.2307/259350.

Pietroforte, Roberto. (1997). Communication and governance in the building process. Construction Management & Economics. 15. 71-82. 10.1080/014461997373123.

Qaisar, S. and Khawaja, K.F. (2012). Cloud Computing: Network/Security Threats and Countermeasures. Interdisciplinary Journal of Contemporary Research in Business, 3(9), 1323-1329.

Q. Zhang, L. Cheng, and R. Boutaba. Cloud Computing: State-of-the-Art and Research Challenges. Journal of Internet Services and Applications, 1:7–18, 2010.

Rockart, J. F., & Bullen, C. (1981). A primer on critical success factors. *Center for Information Systems Research Working Paper*, (69).

Ramaprasad, A., & Williams, J. (1998). The utilization of critical success factors: a profile. In *Proceedings of the 29th Annual Meeting of the Decision Sciences Institute*.

Rashmi, Sahoo, G. and Mehfuz, S. (2013). Securing Software as a Service Model of Cloud Computing: Issues and Solutions. International Journal on Cloud Computing: Services and Architecture, 3(4), 1-11. Doi: 10.5121/ijccsa.2013.3401

Rappa, M. A. (2004). The utility business model and the future of computing services. *IBM systems journal*, *43*(1), 32-42.

Rochwerger, Benny & Breitgand, David & Levy, Eliezer & Galis, Alex & Nagin, Kenneth & Martín Llorente, Ignacio & Montero, Rubén & Wolfsthal, Yaron & Elmroth, Erik & A. Cáceres, Juan & Ben-Yehuda, Muli & Emmerich, Wolfgang & Galán, Fermín. (2009). The RESERVOIR Model and architecture for open federated cloud computing. IBM Journal of Research and Development. 53. 4. 10.1147/JRD.2009.5429058.

Rahimah K, Latipah N, R.Mahat, & W. Najat W. (2016). The organizational critical success factors of cloud computing implementation. Malaysian Journal of Industrial Technology, 1 (1), 38-55.

Seo, J. H., Min, J. S., & Lee, H. (2014). Implementation strategy for a public service based on cloud computing at the government. *International Journal of Software Engineering and Its Applications*, *8*(9), 207-220.

Sambamurthy, V., & Kirsch, L. J. (2000). An integrative framework of the information systems development process. *Decision Sciences*, *31*(2), 391-411.

Sekaran, U. (2000) Research Methods for Business: A Skill Business Approach. John Wiley & Sons, New York.

Smith M., Leung D.W., Gillam S., Astell C.R., Montgomery D.L., Hall B.D., (1979) Sequence of the gene for iso-1-cytochrome c in Saccharomyces cerevisiae. *Cell* 16(4):753-61

Staten, J. (2008) "Is Cloud Computing Ready for the Enterprise?" http://vu2aut.persiangig.com/ECommerce/Forrester-Cloud-computing-report080307%5B1%5D.pdf (current Mar. 11, 2010).

Srinivasan, L. and Treadwell, J. (2005). An overview of service-oriented architecture, web services and grid computing. Hewlett-Packard Development Company, V02, 11/2005.

Segars, A. H., & Grover, V. (1998). Strategic information systems planning success: an investigation of the construct and its measurement. *MIS quarterly*, 139-163.

Stake E., Robert. (1995). The art of Case Study Research. 10.2307/329758.

Thyer, B.A. (1993). Social work research and evaluation. Peacock Publishers, IL Itasca.

Thyer, B. A. (1993). Single-system research designs. *Social work research and evaluation*, *4*.

Tilley, P. A., & Barton, R. (1997, July). Design and documentation deficiency-causes and effects. In *Proceedings of the First International Conference of Construction Process Reengineering, Gold Coast, Australia* (pp. 703-712).

Uma Sekaran. (2000). *Research methods for business: A skill-building approach*. John Wiley & Sons.

Yin, R. K. (2002). Case study research: Design and methods. Thousand Oaks, CA: SAGE Publications.

Yin, R.K. (2009). Case Study Research: Design & Methods.

Venkatraman, N. (1989). The concept of fit in strategy research: Toward verbal and statistical correspondence. *Academy of management review*, *14*(3), 423-444.

Walsham, G. (1995). Interpretive case studies in IS research: nature and method. *European Journal of information systems*, *4*(2), 74-81.

Walsham, G. (1995). Interpretive Case Studies in IS Research: Nature and Method. European Journal of Information Systems. 4. 10.1057/ejis.1995.9.

Webster, Jane & Watson, Richard. (2002). Analyzing the Past to Prepare for the Future: Writing a Literature Review. MIS Quarterly. 26. 10.2307/4132319.

Ziemba, E., & Papaj, T. (2012, September). E-government application at the regional level in Poland—the case of SEKAP. In *2012 Federated Conference on Computer Science and Information Systems (FedCSIS)* (pp. 1047-1054). IEEE.

Ziemba, E., & Papaj, T. (2013, June). A pragmatic approach to the e-government maturity in Poland–Implementation and usage of SEKAP. In *Academic Conferences International Limited, Varese, Italy* (pp. 560-570).